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# POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29. Index to Advertisers and Classified Index Following Reading Matter. No. 23.

TRADE PENBERTHY MARK

AUTOMATIC INJECTORS

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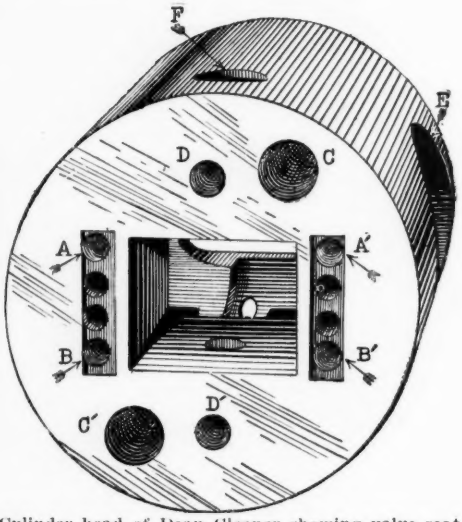
THE WORLD'S STANDARD BOILER FEEDER

Manufactured by PENBERTHY INJECTOR COMPANY. 355 Holden Ave., Detroit, Mich., U. S. A.




Cylinder head of Dean Cleaner showing valve seat and ports.

Now and then we run across an engineer who is afraid even to try the Dean Cleaner, fearing it might injure his tubes.

**You can regulate the force of the Dean's blow regardless of the amount of pressure employed.**

That's why the DEAN is a safe tool to use in cleaning boiler tubes.

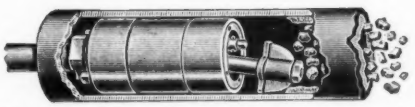
That's why the DEAN can be employed in cleaning thin copper condenser tubes without injuring them.

That's why you can use a DEAN indefinitely without harmful effect on the tubes.

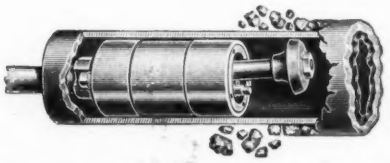
**The force of the DEAN'S blow is regulated by the VOLUME of power admitted to the piston chamber and NOT BY THE PRESSURE. The latter merely increases the RAPIDITY of the blows.**

If for any reason it is desired to reduce the force it is only necessary to plug up A and A' (ports through which the steam or air enters the piston chamber). If it is desired to reduce the force further, plug up B and B' also. Plugs for this purpose are furnished.

The DEAN BOILER TUBE CLEANER removes scale thoroughly, quickly and easily from the tubes of all kinds of boilers and condensers. We loan it for a thorough test in one boiler, free of charge.



The Dean removing scale from the tube of a water tube boiler.



The Dean removing scale from the tube of a return tubular boiler.

**TO KEEP YOUR BOILERS CLEAN YOU'VE GOT TO USE A DEAN.**

*Write for booklet No. 130.*

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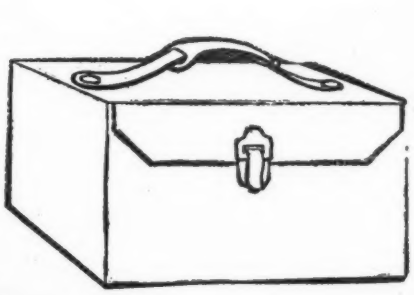

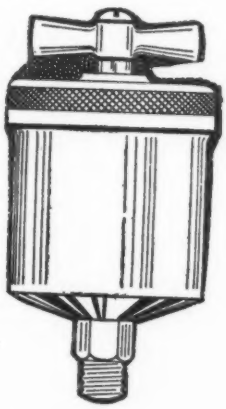

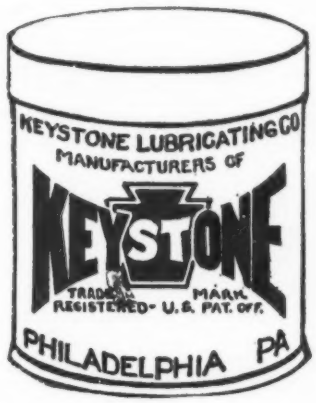

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## A Large Can Of Keystone Grease
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Dec. 8-08, Dept. B

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A hundred pennies spent for EBONITE bring you about a hundred dollars worth of pure satisfaction. In fact the joy EBONITE gives you is fully equal to the joy of finding money. You should know EBONITE—but perhaps you don't. So write today for particulars and samples to try in the hardest joint in your plant. What makes EBONITE so vastly superior to all sheet packings is its complete mastery of *super-heated steam and high steam pressures.* It is without an equal for such work but equally superior for all other kinds of joints.

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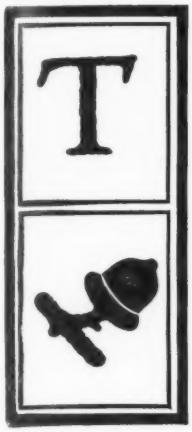
# The House of Dearborn



THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

Thus began the work of the DEARBORN COMPANY. That it has been successful is attested by the fact that thousands of steam plants use their products, prepared according to analysis of the waters, and find absolute relief from the troubles formerly experienced.

With its large corps of representatives, all of whom are *mechanical experts*, working in all sections of the country, backed by the scientific laboratory work done at Chicago, the Dearborn Company is able to give personal attention to every case, making careful study of the water and plant conditions and furnishing treatment that exactly meets requirements.

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# Smooth-On Will Fix It

You'd rather allow pipe line leaks like this to go on than to shut down and fix the trouble. But turning your back isn't going to ease your conscience, or pay for the wasted steam.

There's a way, though, to make leaky joints **permanently tight.** Apply Smooth-On to the leak forcing it into the opening, using Smooth-On Elastic Cement on hot pipes and Smooth-On Iron Cement No. 1 on cold pipes. Then wrap the joint with Smooth-On Tape as per directions in our new instruction book, which will be sent free to any engineer sending us his name and address.

Smooth-On Cements can be used for a thousand and one purposes around the power plant. *Write for particulars.*

## Smooth-On Mfg. Co.

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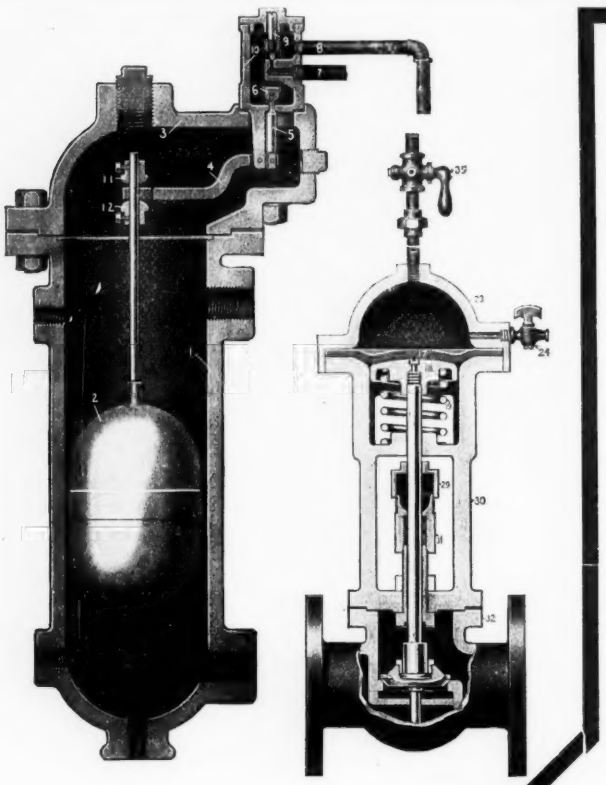
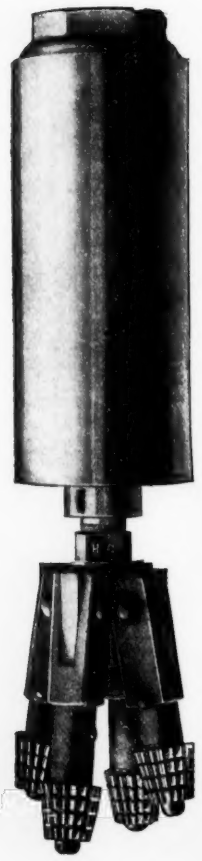


# "LIBERTY"

Feed Water Regulators have numerous advantages of greatest importance. They are positive in operation, have no slide valves, gravity-operated valves, thermostats or leakage valves in their construction. There is no regulator on the market that compares with the **Liberty** in simplicity, durability and close regulation.

## LIBERTY MANUFACTURING COMPANY,

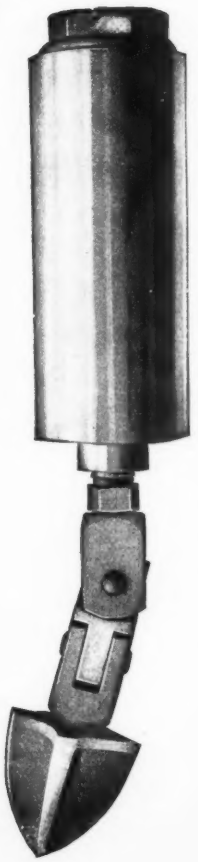
**6509 Susquehana Street, Pittsburg, Pa.**



Liberty Turbine Cleaners are by far the most powerful, effective tube cleaning devices ever made. They remove the thickest scale without the slightest injury to the tubes, and easily clean two tubes while any other is cleaning one. For example, a 4-inch 18-foot tube, containing scale 1-inch thick, can be cleaned perfectly in 20 minutes, with one man operating. Isn't that the sort of cleaner you want?

When you need Regulators, Tube Cleaners, Separators, Strainers, Oil Purifiers, etc., look up the kind branded

# "LIBERTY"



# BOILER CORALLINE COMPOUND

REG.U.S.PAT.OFFICE

¶ CORALLINE Boiler Compound will soften and dissolve the hardest boiler scale in existence.

¶ Prevents foaming and pitting of boilers.

¶ Does away with the deleterious effect of oil or grease in boilers.

¶ Causes no discoloration where live steam is used and does not affect the most delicate fabric it may come in contact with.

¶ It does not affect the sheets or tubes of boilers or interfere with the joints or packing. In fact it stands alone, unequalled by any goods purporting to do the work.

¶ If you are a large user of steam try a barrel of all the different makes of compound on the market, giving them a fair and impartial trial, and then **let us send you a barrel free,** compare ours with others and we will receive all your orders in this line thereafter.

¶ Send us a gallon of your boiler feed water or a piece of scale made from the water you use, we will analyse the same free of cost to you and make you the most liberal proposition within the sphere of reason.

## Coralline Drug & Chemical Co.

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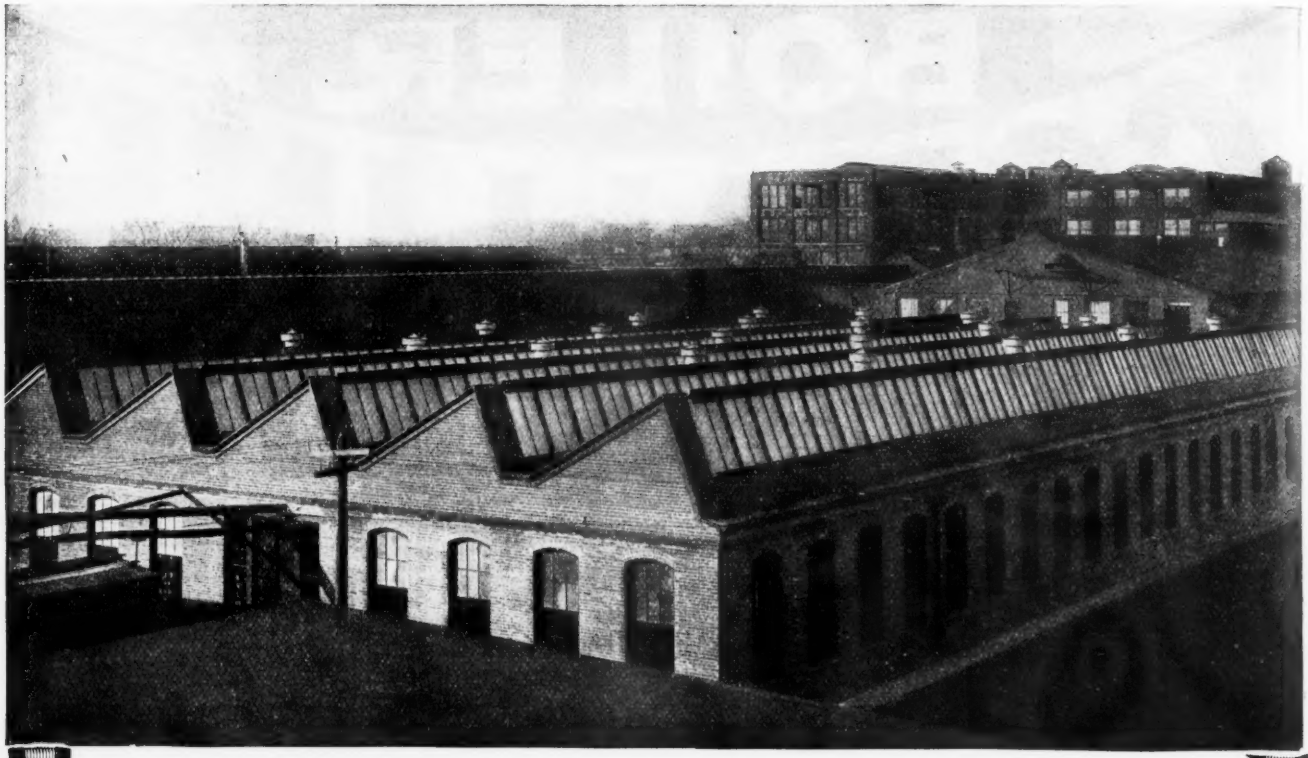
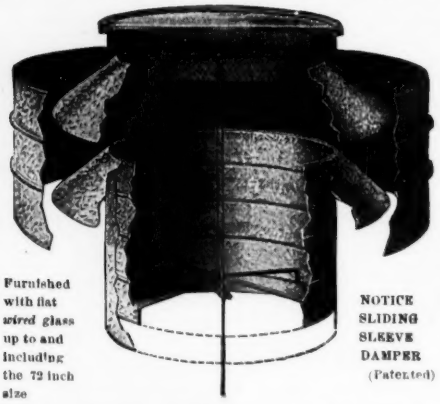


## For Perfect Factory Ventilation—

# Burt Ventilators

Metal top with sliding-sleeve damper (patented).

are acknowledged the most efficient, economical and durable on the market, a fact which is proved by the large repeat orders we receive from all over the world.



Furnished with flat *wired* glass up to and including the 72 inch size

NOTICE SLIDING SLEEVE DAMPER (Patented)

The above illustration shows the plant of The Yale & Towne Mfg. Co., at Stamford, Conn., which is supplied with pure air by the 20 Burt Ventilators shown. This is one of many installations.

These devices are strong, extra heavy and weather-proof. They positively draw all impure air, smoke, steam and gas from buildings and they require no attention or expense for operation.

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**Largest Manufacturers of Oil Filters in the World.**

George W. Reed & Co., Montreal, Sole Manufacturers of "Burt" Ventilators for Canada.

# A Clean Cut Factory Gas Power Plant

## A 60-Cycle Plant Operating in Parallel at Swissvale, Penn.; All Piping and Wiring Are Located out of Sight and Kept Separate

BY CECIL P. POOLE

The Union Switch and Signal Company, Swissvale, Penn., recently completed a new power house which is a model of good practice in this branch of engineering. The building is constructed wholly of concrete, steel, glass and tile, and is therefore fireproof; moreover, it has been planned with unusual skill, with the result that all pipes, valves, wires and safety devices in the plant are easily accessible without disturbing anything else.

The power equipment thus far installed comprises three 340-kilowatt and two 90-kilowatt alternators driven by gas engines, two belt-driven and two motor-driven exciter dynamos and a small motor-generator for ignition purposes. Space has been provided for three more of the large units, and judging from the rate at which the power plant has grown during the past few years it will not be long before the projected equipment becomes necessary.

The lay-out of the plant is shown by Fig. 2. A 6-foot "steadying" gas tank is provided in the basement between each pair of large engine foundations, and 10-inch supply pipes lead from this tank to the intake manifold of each engine of the pair (No. 4 engine is not yet installed, however). The gas flows to the two steadying tanks through gasometers, which maintain an approximately constant pressure in the tanks. At present the plant is running on natural gas, but a 16- to 28-inch main has been laid to bring gas from a battery of producers to be installed near the power house in the future. The small engines take their gas directly from the gas main. They are located between the larger engines, as shown in Fig. 2, and are of the well known Westinghouse three-cylinder vertical type, with 13 inches diameter of bore and 14 inches stroke. They drive 90-kilowatt two-phase alternators at 260 revolutions per minute, through flexible couplings. These machines deliver current at 220 volts and 60 cycles and are operated in parallel with the large generators whenever the load requires it.

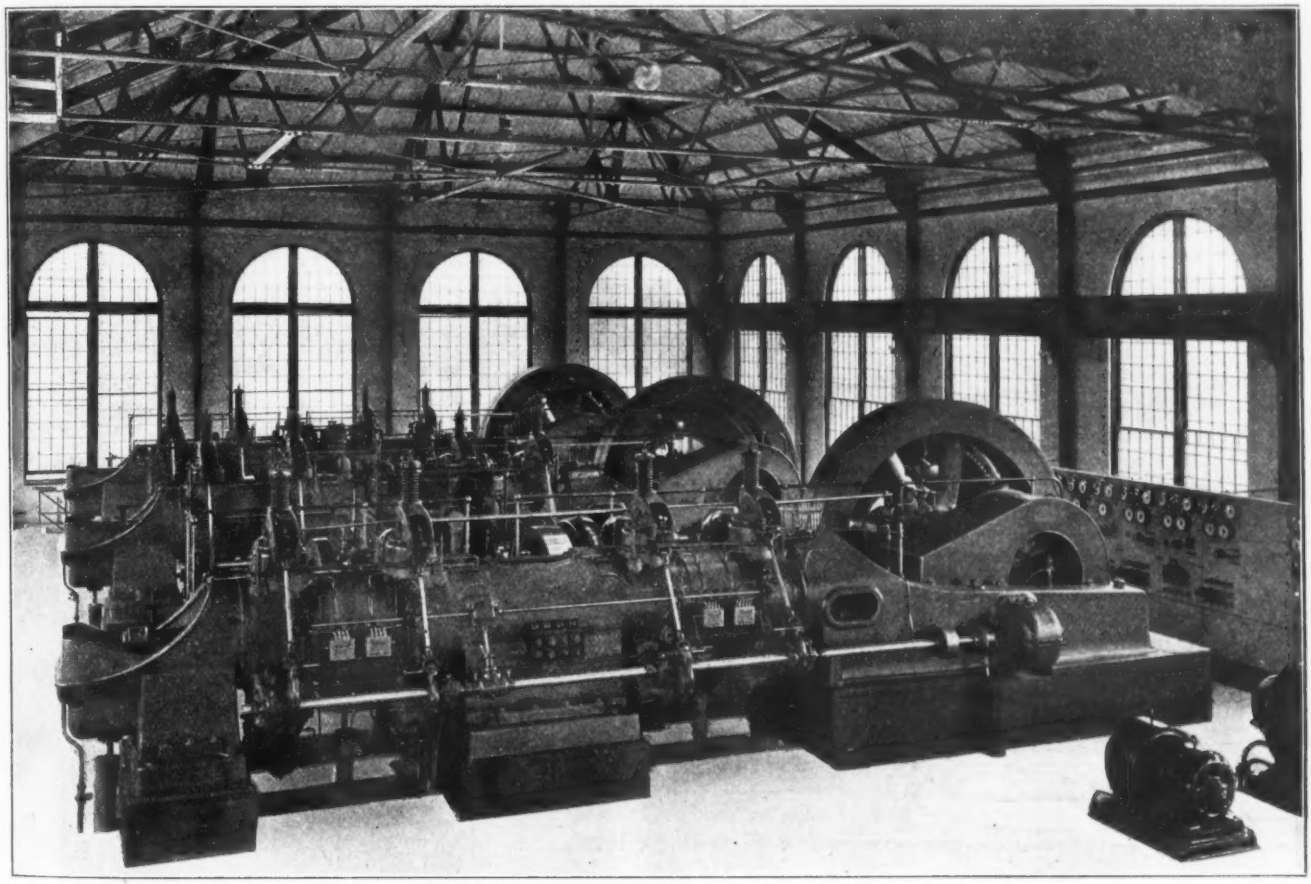


FIG. 1. POWER-HOUSE EQUIPMENT OF THE UNION SWITCH AND SIGNAL COMPANY

### Features of the Large Engines

The large engines are Westinghouse tandem double-acting machines with 23½ inches diameter of bore and strokes of 33 inches. They are now running on natural gas, but were designed for producer gas and are therefore equipped temporarily with special mixing valves to facilitate the use of the richer gas. They drive 340-kilowatt Westinghouse revolving-field alternators which supply two-phase cur-

rents at 220 volts and 60 cycles, and the speed is 150 revolutions per minute; the engine-piston speed is, consequently, 825 feet per minute. These engines are similar in design to the Bessemer engines described in POWER AND THE ENGINEER for April 28, 1908. The inlet and exhaust valves at each end of a cylinder are both operated by a single eccentric, as shown by Fig. 4, and the exhaust valve is water-cooled, of course. The mixing valve for each cylinder-end consists of a cylinder mounted on the stem of the main admission valve so that it moves up and down with the inlet valve, but is free to rotate about the valve stem under the influence of the governor. The mixing valve has ports cut in one side of it to correspond with similar ports in the wall of the valve chamber, as shown by Fig. 4. When the admission valve is open, the mixing-valve ports are on the same level with the wall ports, but the position of the governor linkage determines how much of the wall ports are uncovered. For lean gases, the gas ports in the valve and chamber walls are, of course, made larger with respect to the air ports than for rich gases. When the admission valve is closed the mixing valve covers the wall ports and prevents the mingling of gas and air in the passages leading into the cage.

Each piston is cast in one piece and mounted exactly midway on the rod, as indicated by Fig. 5. The two rods are exactly alike, so that any rod and piston may be used in either cylinder; moreover, a rod may be turned end for end, if for any reason this may be desirable. The fittings at the ends are such that when a rod is turned end for end it is also necessarily rotated about its axis 180

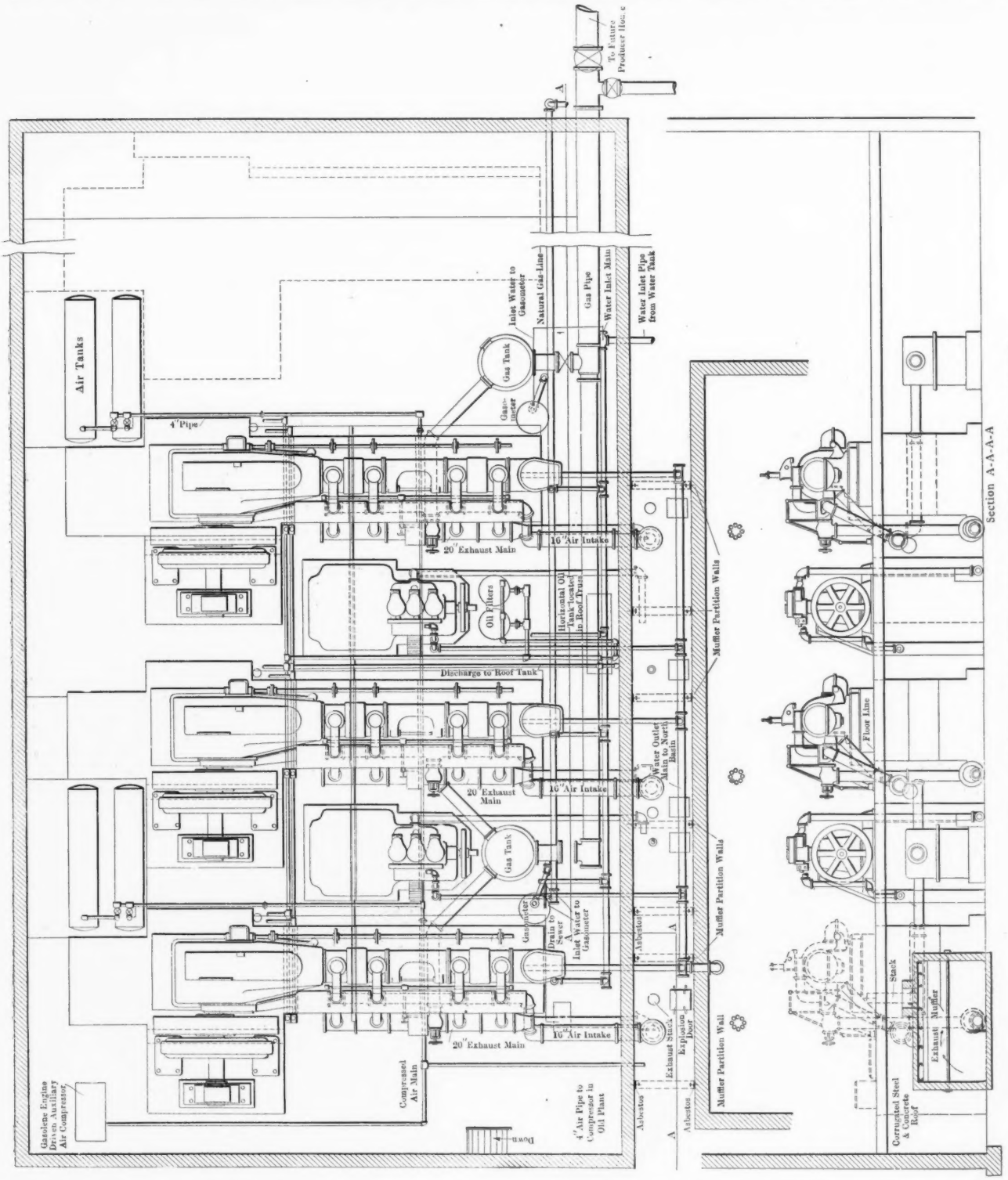
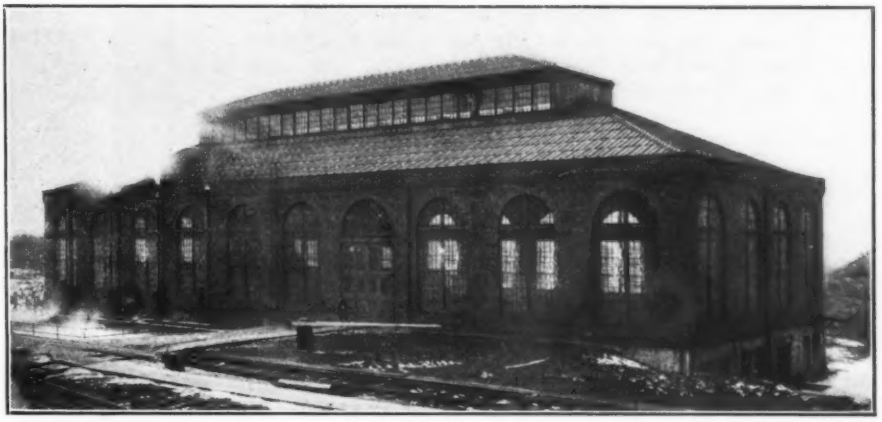



FIG. 2. PLAN AND END ELEVATION OF ENGINES AND CONNECTIONS

degrees; this preserves the proper direction of water flow into and out of the piston and makes it impossible for a piston to be put in "upside down" when erecting or reassembling an engine.

### Ignition

The igniters are of the simple mechanical make-and-break type, with both electrodes insulated, however. There are two igniters in each end of each cylinder, one near the top and the other near the bottom of the cylinder bore, and both are operated by one trip, as may be seen by reference to Fig. 6. An electromagnet is included in each igniter circuit and a light pivoted armature shows the excitation of the magnet and therefore the proper operation of the electrical circuit every time the igniter contacts close. These electromagnetic telltales are all mounted together in a bank on the side of the engine over the middle pedestal; the group on the third engine is shown clearly in Figs. 1 and 6. The ignition current is supplied by a 1-kilowatt motor-generator, at 110 volts. The motor is operated from the main busbars. The igniter wiring is all run in iron conduits, and each ignition circuit is provided with a safety fuse in order that trouble on any one circuit will not affect the other circuits.



UNION SWITCH AND SIGNAL COMPANY'S POWER HOUSE

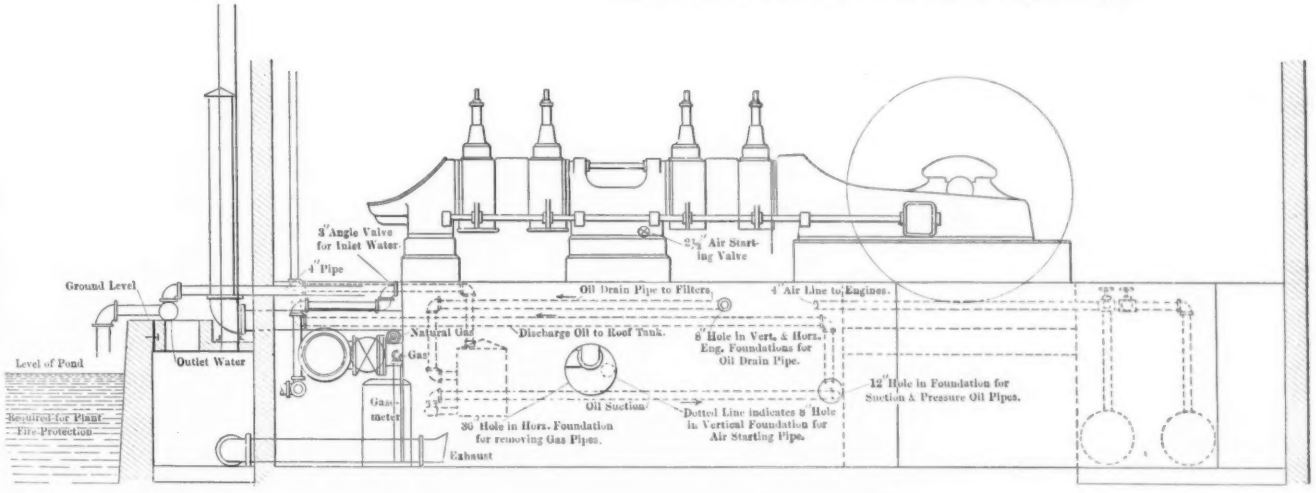

3" Angle Valve for Inlet Water
4" Pipe
Ground Level
Level of Pond
Outlet Water
Required for Plant Fire Protection
Natural Gas
Gas
Gas meter
Discharge Oil to Roof Tank.
Oil Suction
Oil Drain Pipe to Filters.
2½" Air Starting Valve
4" Air Line to Engines.
8" Hole in Vert. & Horz. Eng. Foundations for Oil Drain Pipe.
12" Hole in Foundation for Suction & Pressure Oil Pipes.
36" Hole in Horz. Foundation for removing Gas Pipes.
Dotted Line indicates 8" Hole in Vertical Foundation for Air Starting Pipe.
Exhaust

FIG. 3. SIDE ELEVATION OF ENGINES AND CONNECTIONS

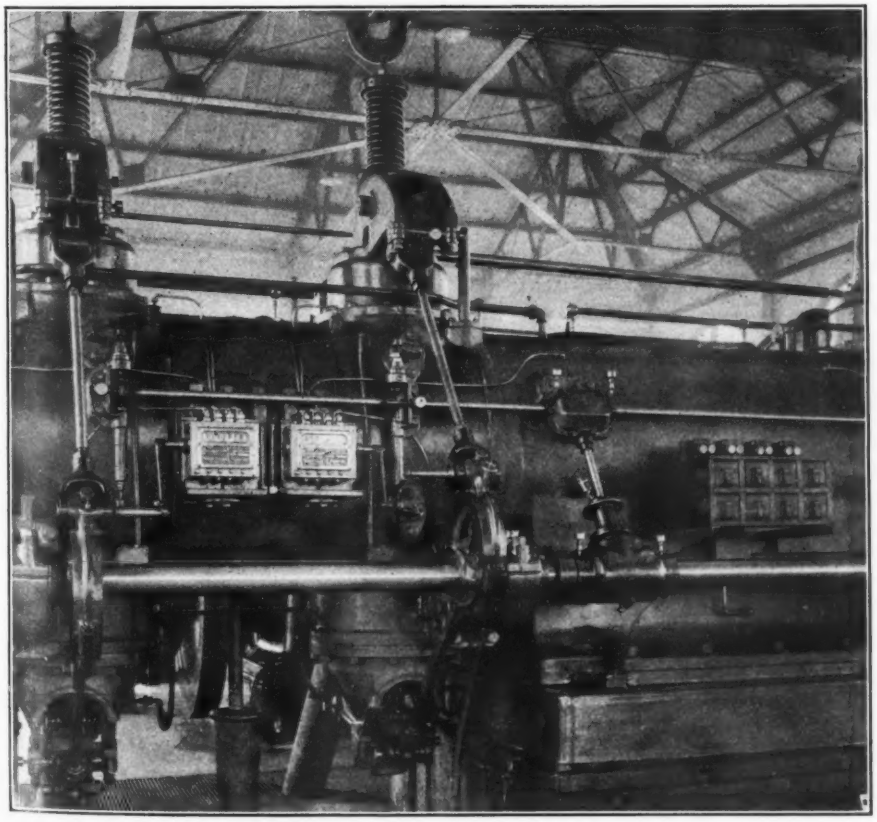


FIG. 6. IGNITER GEAR, TELLTALES AND LUBRICATORS

### Auxiliaries

There are two exciter sets for the large engines, one of 75 kilowatts and the other of 25 kilowatts capacity. The exciters are driven by induction motors of 125 and 40 horsepower, respectively, taking current from the station busbars. The exciters for the 90-kilowatt alternators are belt-driven from the generator shafts. In the event of a complete shutdown of the whole plant, therefore, one of the small units would be started first and this would supply current for the motor of one of the larger exciters until a large unit had been put into operation.

Compressed air is used for starting all of the engines, as usual nowadays, but

ordinarily the air from the tanks in the shops is used; the pressure is only 60 pounds per square inch, but the large engines start on it without difficulty. A compressor driven by a gasolene engine of 5 horsepower is provided, however, to keep the station tanks up to pressure in case of any interruption of the supply from the shop tanks. The compressor and tanks are located in the basement of the power house (see Fig. 2), which is unusually light and spacious.

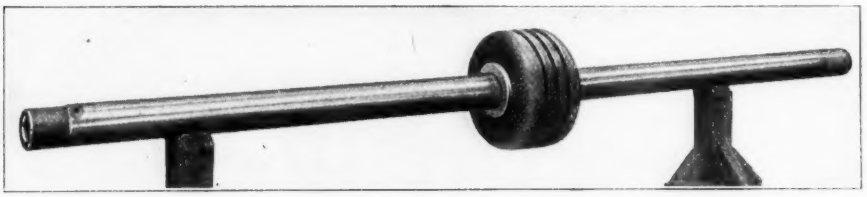


FIG. 5. PISTON AND PISTON ROD

All of the piping and wiring are located in the basement also, and their arrangement is particularly neat, clean-cut and accessible, as Figs. 7 and 8 indicate. A noteworthy feature in this connection is that the wiring is all on one side of the basement and the piping is all on the opposite side.

### Cooling and Muffling

The cooling-water system is unusual in several respects. The water from the jackets is discharged into a pool just outside of the power house, from which it passes to a second pool; from this one it is pumped to a tank which is 40 feet above the level of the engines, and descends by gravity from the elevated tank to the engine jackets. No cooling tower is used, the water losing 40 to 50 degrees of temperature in passing through the system of pools and tanks. The pools in the ground are walled in with concrete and the water in them is from 14 to 16 feet deep. While some heat is dissipated by surface evaporation, much of it appears to be transferred to the earth through the walls of the pools. The temperatures during the writer's visit were 120 degrees at the jacket discharge and 80 degrees at the inlet. Fig. 9 gives a view of the cooling ponds.

Another unusual arrangement is that employed for muffling the exhaust. The exhaust gases from each engine are delivered horizontally against a baffle wall in an underground compartment and escape from the opposite end of this compartment by way of the usual vertical exhaust pipe. The exhaust gases, moreover, are cooled considerably by water circulated through small pipes located within the exhaust main of each engine.

### Lubrication

The cylinders, piston-rod packings and exhaust-valve stems are supplied with the same kind of oil from force-feed lubricators mounted on the engines (see Fig. 6); these are the well known product of the Sight-Feed Lubricator Company, of Milwaukee, and work on the "timed" system characteristic of that company's gas-engine lubricators. The cranks, wristpins and all of the other bearings are supplied from one sight-feed manifold on each engine, and the oil flows by gravity to the

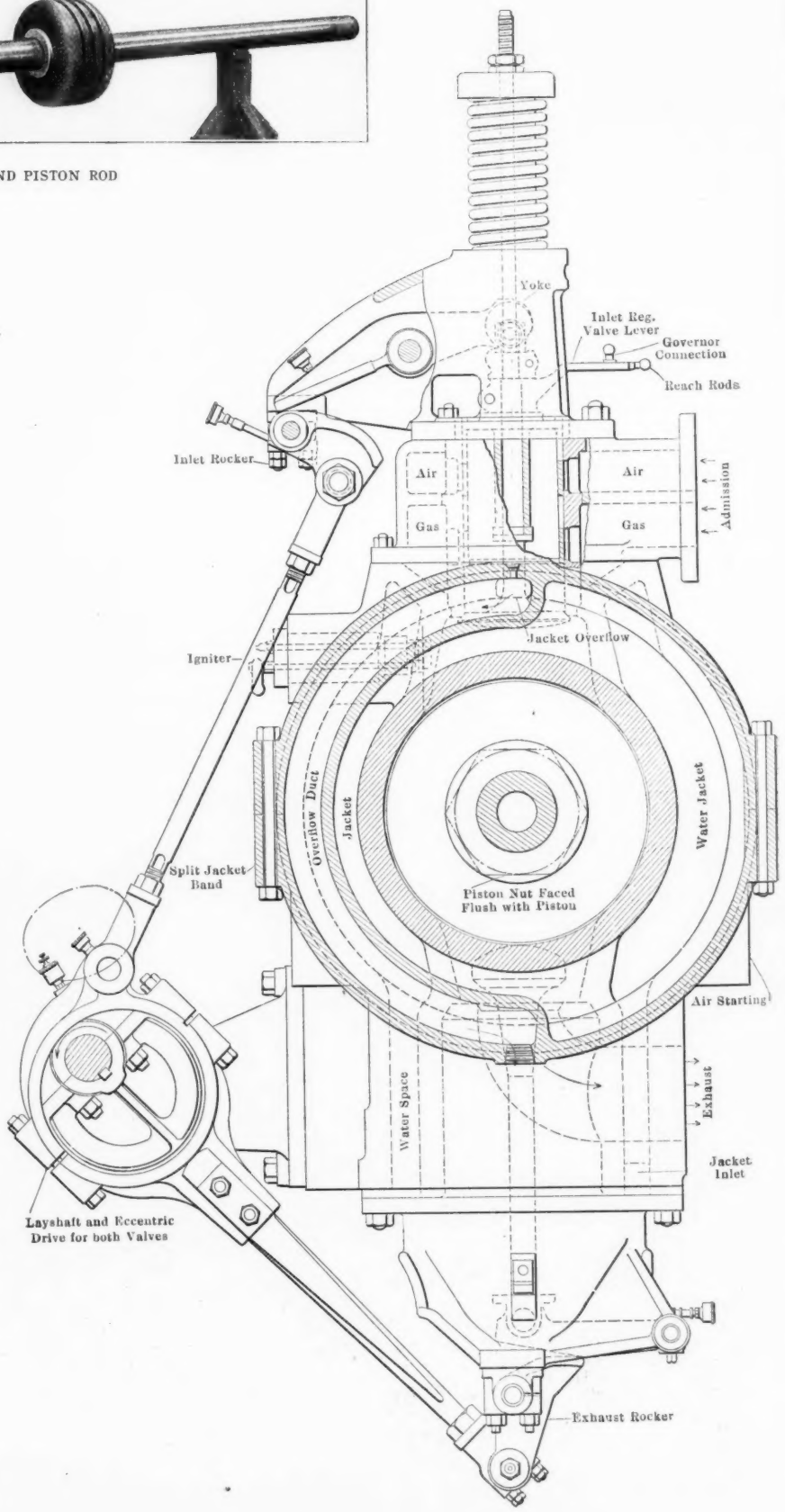



FIG. 4. VALVE GEAR AND MIXING VALVE

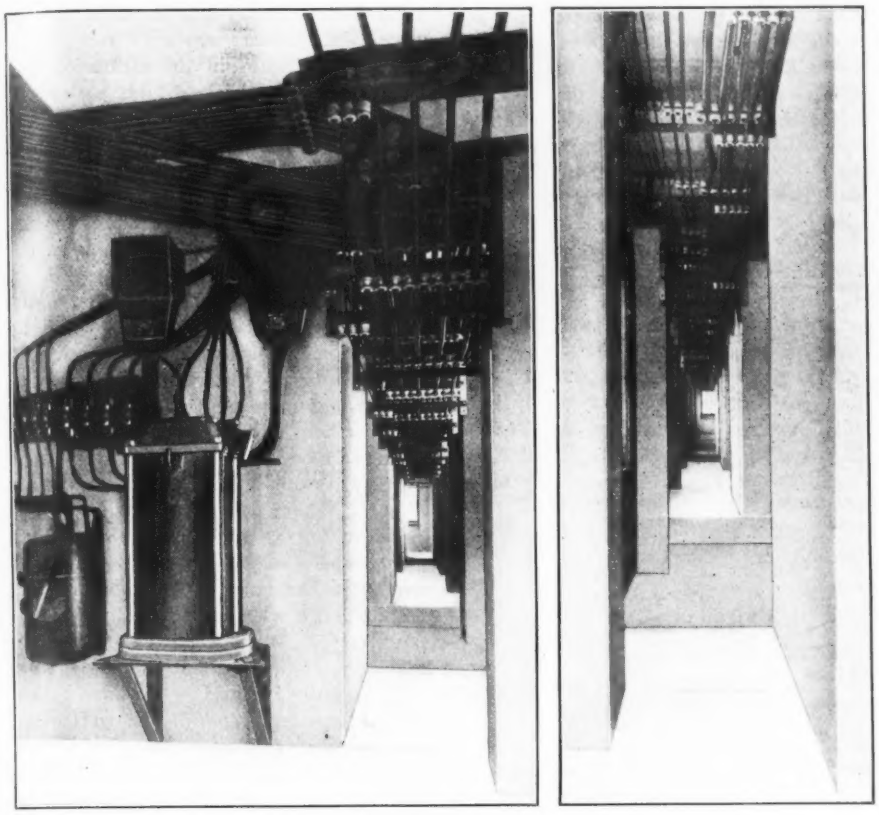


FIG. 7. MOTOR STARTERS AND WIRING ALLEY IN BASEMENT

manifolds from a tank supported on the horizontal members of the roof structure. The used oil passes from the various bearings to the crank pit of each engine whence it is led to a pair of filters in the basement. From the filters it is forced back up to the roof tank by pumps gear-driven by the large engines.

REGULATION

It is a common habit of writers on gas-engine principles to explain that one of the disadvantages of "quantity" regulation is that at light loads the compression is so low that the engine is liable to miss an explosion occasionally. This is true of many engines and the writer confesses to having supposed it to be true of all, except where some very special provision is made to prevent it. Fig. 10 and personal observation of the engines in this plant, however, seem to demonstrate that there are exceptions to the rule. This engraving is a reproduction of part of a continuous indicator diagram taken in October, this year, from the Bessemer engines, which are of exactly the same type as the Swissvale engines, but have cylinders of 38 inches bore by 54 inches stroke, making it even more difficult to fire a small charge than it would be in smaller cylinders. The diagram needs no explanation. At the time of the writer's visit to the Union Switch and Signal plant, the load ranged from about 100 to 400 kilowatts, with one large and one small unit running, and the large engine never missed an explosion during a period of ten minutes' watching.

A most interesting incident occurred during the writer's visit to the Swissvale plant. One large and one small unit were operating in parallel. The large units are equipped each with a safety trip which is thrown by a finger on the flywheel when the speed becomes excessive, and which

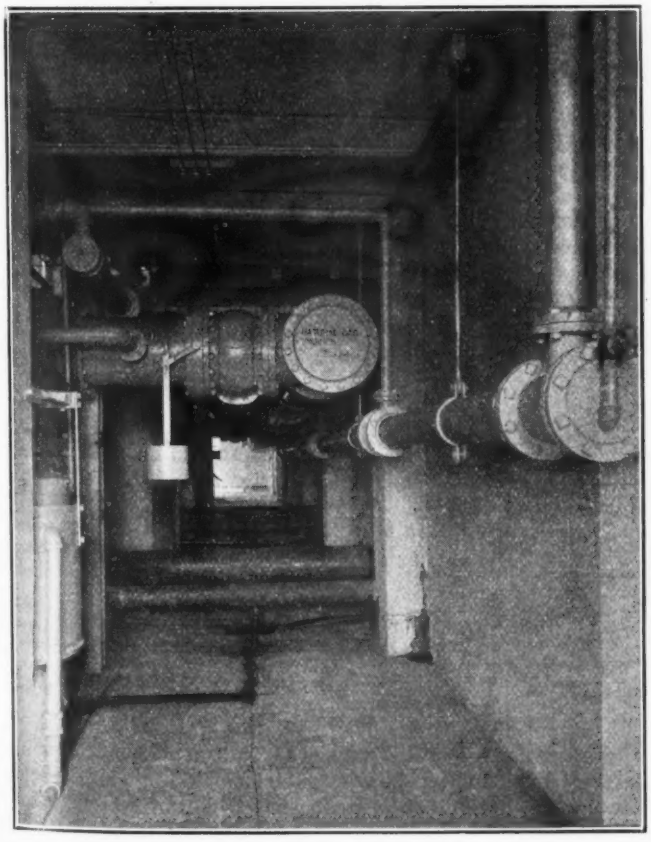


FIG. 8. PIPING ALLEY IN BASEMENT

FIG. 9. JACKET-WATER COOLING PONDS

opens the ignition circuits of the engine. The contacts on the trip of the engine then running had become loosened or disarranged so that they did not close the circuit tightly, and there was a slight arc between them. After awhile the contacts let go entirely, opening the ignition circuits, and the big engine began to slow down, dragging with it, of course, the 90-kilowatt outfit which was in parallel. The speed fell to about 100 revolutions per minute before the attendant reached the safety trip and closed its contacts; immediately, the engine began to pick up, and in a few seconds it regained normal speed, the small unit remaining in step with it throughout the abnormal changes in speed. As this is a 60-cycle installation, this performance is rather remarkable. Unfortunately, the writer could not get to the switchboard in time to see just what happened to the little unit during the drop and rise in speed.

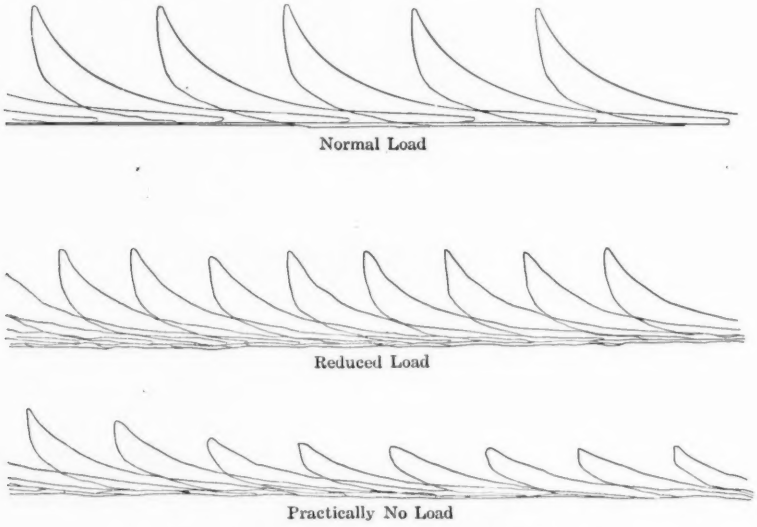



FIG. 10. PARTS OF A CONTINUOUS INDICATOR DIAGRAM

## Some Indicator Diagrams

By F. L. Johnson

When I returned from lunch the next day after my friend Sawyer's visit, I found him seated by my desk reading Low's "Steam Engine Indicator."

"Do you know," he said, "I think it is really too bad that so many good books get out of print. This is the first work on the indicator that I ever read, and I really think it is the best one I have seen. It is sort of an old friend.

"I promised you the other day that I would show you some indicator diagrams and here they are.

"This pair (Fig. 1) shows pretty plainly the difference between an engineer and a stopper and starter. These diagrams were taken from a 10¾x36-inch engine running at 80 revolutions per minute. The valve gear is of the riding-cutoff type and was set to cut off so early in the stroke that it re-opened at about one-half stroke and filled the cylinder with steam at near boiler pressure just before the exhaust opened. You can see pretty well that the steam had hard work to get out of the way for the next stroke.

"The second one shows how steam was distributed after an engineer got a chance to monkey with the valve setting. I have no idea of the amount of coal that was saved by the change in valve setting, but I do know that the owner, who willingly paid the coal waster $13.50 per week, thought the engineer a hog because he would not work for less than $20, and let him go after the plant was in good running order all over.

"Engineers must expect this sort of thing once in a while, and I do not know as there is any help for it. As long as the supply exceeds the demand these things will happen.

"Now here is a pair of diagrams (Fig. 2) given me by an engineer who believes in balancing the load between the cylinders and keeping the engine quiet by plenty of compression. His engine runs as well as any engine needs to run and is carrying about two-thirds of its rated load. One day the condenser went on a strike and the load was not balanced between the cylinders any more, nor did the compressed steam in the clearance give back to the flywheel all the power absorbed in its compression. Some of the load had to be taken off the engine until the condenser could be induced to go to work again, and, as this was several days, it looked to me as though compression for quiet running is not the best thing in the world, in all cases.

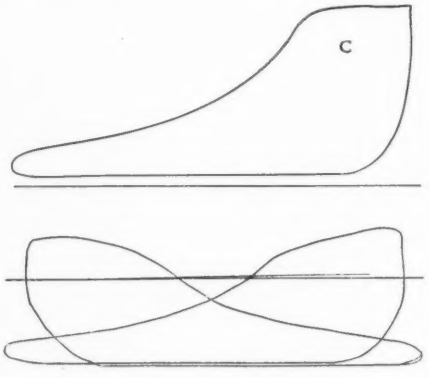



FIG. 2

"This pair of diagrams (Fig. 3), which were taken with about two-thirds of the regular load, shows pretty plainly why the engine would not carry a full load non-condensing.

"Now here is another pair of diagrams from a 1200-horsepower Corliss engine (Fig. 4), running at 100 revolutions per minute. These were given to me by the engineer of a good-sized electric-light plant, where all of the engines are run without either much lead or compression. I should not wish to see any better running engines than I saw there, and I asked the engineer about keeping the engines keyed. He said: 'We have to key up the crosshead end of the rods about once in six or seven weeks, while the crank pins will run a year or more without keying. It would be the same with the crossheads if engine builders would show a little common sense in the selection of material for crosshead pins and boxes. But somehow it looks as though the whole family of engine makers has

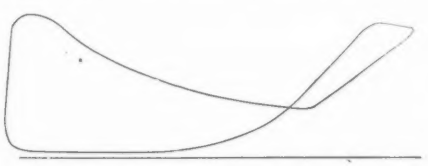


FIG. 1

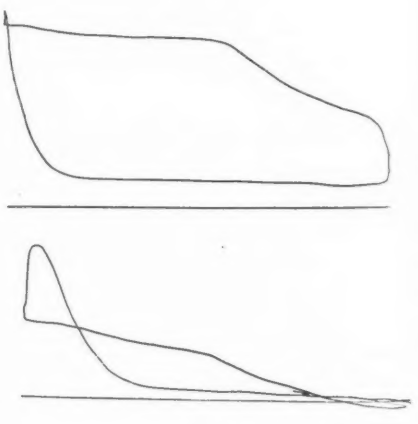


FIG. 3

gone steel-crazy and are using steel for everything under the sun, even where a moment's thought would show that for some purposes steel is the worst possible material that could be selected, and crosshead pins is one of these.'

"But I am getting away from these diagrams. Here is another set (Fig. 5)

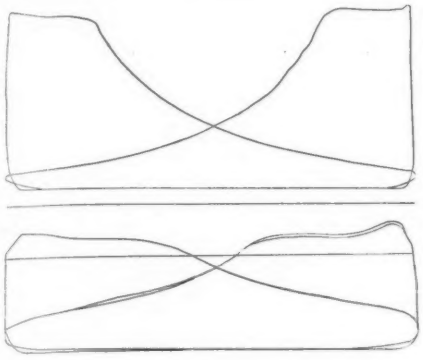


FIG. 4

taken from the engine within fifteen minutes from the time the others were taken. The engine was carrying a load of about 800 kilowatts when the first pair was taken, and while the engineer was looking at them the circulating pump stopped and the vacuum was lost. While the engineer and the oiler were getting the pump into working order, the assistant engineer, who happened to be in the plant, took the second pair of diagrams. The engine did not show any signs of distress, nor did it perceptibly change in speed. There was nothing in the engine room, except the vacuum and receiver gages, that would indicate that the engine was running noncondensing.

"Of course, the men in the boiler room felt the change, but the engine carried the load as steadily and quietly noncondensing as condensing. I am particularly glad that I was able to get these last diagrams, as they prove so much better than

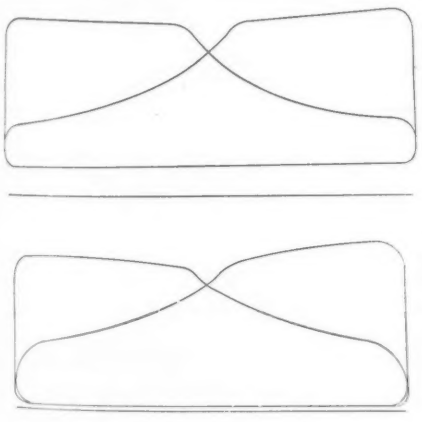


FIG. 5

any words can what I have so often said, which is: If the valves of an engine are set right it will run equally well condensing or noncondensing.

"I am more than glad that I started in the steam-engineering line under the man that I did. Of course, at the beginning it was only some means of getting a living that I was looking for, and I took the first job that I could get. The old engineer was exceptionally kind to me and as soon as I began to show a little interest in the work I had to do, he began to tell me why things were done in a certain way instead of some other way. I was hungry for knowledge and he helped me at every opportunity. How well I remember how he used to come into the boiler room and, after taking a look around to see how things were going, would sit on an old carbon box and begin to tell me things. Some of his talks I have never forgotten. I want to tell you about some of them sometime, and if I do not come to the city again soon, I think I will write to you."

## Refitting a Worn Pump Piston

By J. L. Frederick

The chest piston, as it is called, of a Deane pump had after many long years of service become so worn that sometimes so much steam would blow past that the valve would become inoperative and the pump would stop. For some reason extra parts for this particular pump were not kept on hand, as was the case with all the other pumps in the plant, so the engineer decided upon a repair of his own. After the plant closed Saturday evening the piston was taken and slowly heated in the forge to a dull red and then buried in the ashes and left until Sunday morning. Then, taking an intelligent helper with him, the engineer took the piston from the ashes, cooled and cleaned it and, after several trials, found a way that one end could be made to enter the bored port in the chest.

The end having been entered fairly, with a hickory stick held against the piston the helper drove it through from end to end. Then the chest was reversed and the piston driven back. This was kept up for about two hours, the sledge being replaced by a heavy hammer and the heavy hammer by a lighter one, as the movement of the piston became freer, until it could be easily pushed back and forth with the fingers, when it was thought that it was as good as it could well be.

The chest and piston were put back on the pump and tested. The job was perfectly satisfactory in every way. It would seem that the heat to which the piston was exposed had the same effect upon it that superheated steam has on cast-iron fittings; that is, swelled it a little. The repeated forcing of the piston through its port in the chest compressed the piston and enlarged the port until the fit was what was wanted.

## Ohio Society of Mechanical, Electrical and Steam Engineers

In accordance with the plans of the general committee on arrangements, the first feature of the meeting of this society, which was held at Toledo, November 20 and 21, was a trolley trip around the picturesque Maumee belt line, visiting Fort Meigs and other historic points of interest. A stop was also made at the filtration plant of the Toledo waterworks. This plant is in course of construction, and some very interesting concrete work has been done there. One of the unique features of the installation will be the direct driving of the centrifugal pumps, by means of producer-gas engines.

The afternoon's excursion, with the exercise in the open air, was well calculated to prepare the members and their friends for the banquet which had been arranged for them, and which was served immediately on their return to the Secor hotel. At the banquet the society was welcomed to the city by G. W. Store, secretary of the Toledo Chamber of Commerce. President F. W. Ballard, of the society, responded with a few words of appreciation. Short speeches were also made by G. B. Dunn and LeRoy Beacher, both of Toledo.

Retiring to the auditorium of the hotel, the meeting was formally opened by the president, and G. H. Gamper read a paper on "The Columbus Municipal Lighting Plant," of which he is superintendent. After a complete description of the plant, Mr. Gamper went into the bookkeeping details of his department and showed how records were kept so that all items affecting operating costs were known. The operating cost, including repairs, for a kilowatt-hour delivered to the switchboard was given as 3.9 mills for a recent month, in which the load factor was low and operating conditions not entirely favorable. It was hoped to reduce this considerably in the future.

Mr. Gamper said that he believed a municipal plant under favorable conditions could be operated as cheaply as a private one, but pointed out the many reasons why this is not ordinarily the case.

Another paper discussed was: "Notes on the Water Purification Plant Now Under Construction for the City of Toledo," by William G. Clark. This plant had been inspected during the afternoon and the paper was listened to with interest. At its conclusion a series of lantern slides were shown, illustrating what had been done in many other cities along this line, and showing that the experience gained thereby was being used to make the present installation a model one.

Saturday morning was largely taken up with a business meeting during which re-

ports of the secretary and treasurer were read, and officers elected.

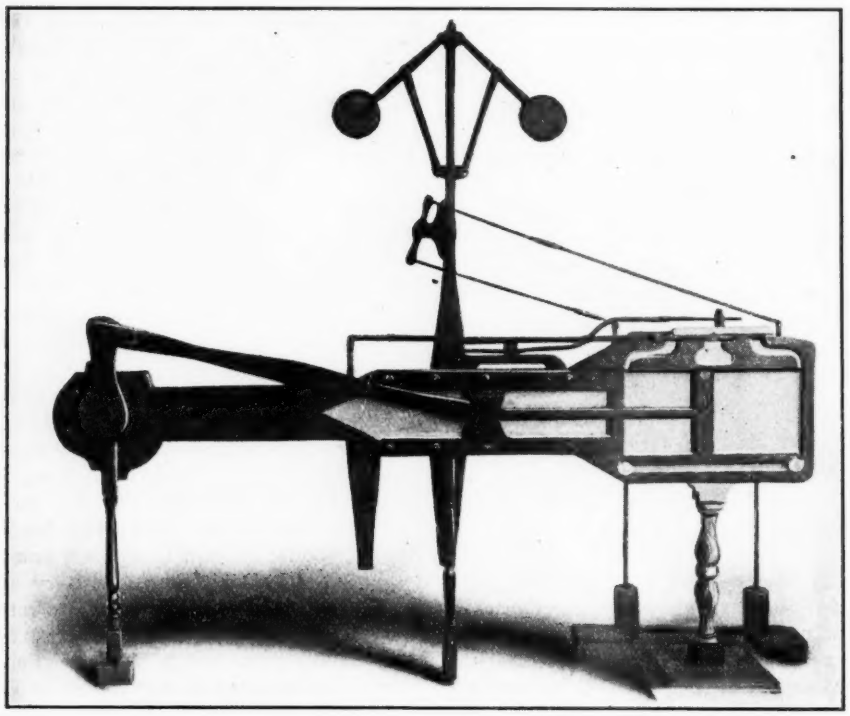
"Single and Double Acting Ammonia Compression" was the subject of a paper by Thomas Baker, who brought out the special features of advantage in the two types, and considerable discussion took place on the subject of fitting piston rings to prevent leakages, not only in ammonia compressors, but in gas engines as well.

Another paper which proved of considerable interest was "Underground Insulation of Steam and Hot Water Pipes," by Harry Gillett. A talk by the president followed, on the special field in which the society may be most useful. It was pointed out that, whereas some societies consisted of theoretically trained men only, and other societies were composed mostly of practical men, it was the province of the Ohio Society of Mechanical, Electrical and Steam Engineers to bring the members of each class together, realizing that each could learn something from the other. The character of future papers was discussed and some investigations were outlined, which, when completed will be of great value to engineers in general, both from the designing and operating standpoints.

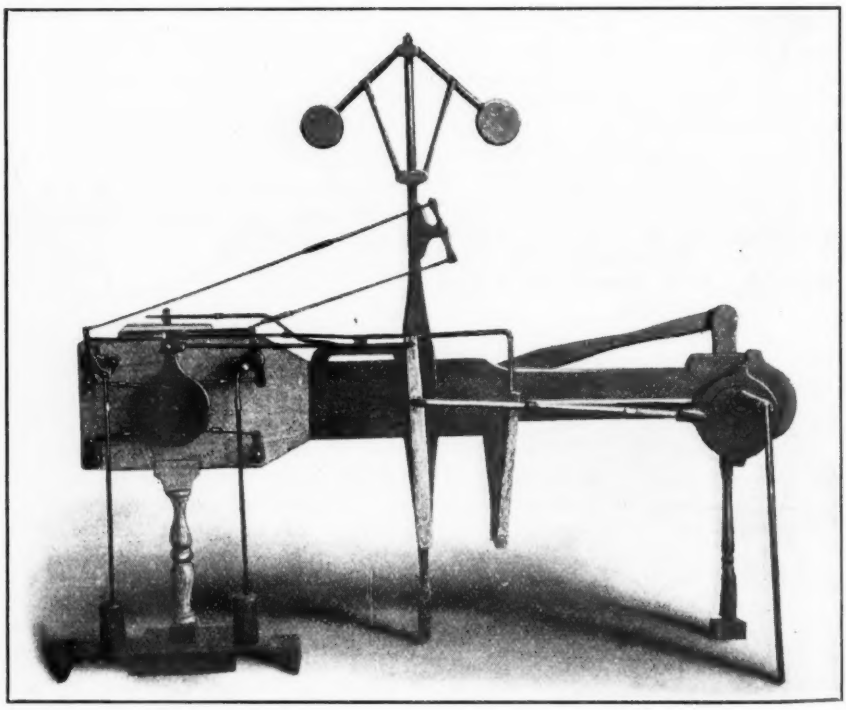
In the afternoon a visit was paid to the plant of the Toledo Ship Building Company, where many things of interest were seen. Among the latter was the hull of a steel passenger steamer, which had recently been built complete and launched in 180 working hours from the time the contract was signed.

In the evening F. C. Caldwell read a paper, illustrated with lantern slides, on "The New Laboratories of the Electrical Engineering Department of the Ohio State University."

Officers for the ensuing term are: Frederick W. Ballard, of Cleveland, reëlected president; William Long, of Toledo; W. M. Davis, of Boston, Mass., and W. C. McCracken, of Columbus, vice-presidents; David Gaehr, of Cleveland, secretary; Mason Chilcote, of Akron, treasurer.



FRONT VIEW OF VALVE-GEAR MODEL



REAR VIEW OF VALVE-GEAR MODEL

## Unusual Valve Gear Model

Three valve-gear models in one machine is the unusual combination that has been effected by A. C. Waldron, engineer of the Bennett estate on Commercial street, Lynn, Mass. The model, which is built mainly of wood and is about 8 feet in length, combines a Corliss valve gear, plain slide-valve gear and riding cutoff in one. One side of the model shows the Corliss gear with wristplate, dashpot, knockoff blocks and all other details. The valve rods are made of ¼-inch steam piping, with right-and-left couplings, with the attachment to the wristplate and valve levers made by an ingenious arrangement of pipe ells to take the place of pins and key heads. Rods running from the governor to the knockoff cams are made of ⅛-inch steel drill rods and are adjustable by right-and-left couplings, like the valve connections. The wristplate hub has the usual center and extreme travel marks, and the valve and ports have the regulation edge marks, by which the valves may be set. In the photograph the ends of the Corliss steam valve are not shown, as they are covered by that part of the model in which the slide-valve ports are cut. This part is quickly removed by taking out two small wood screws which hold it in place, showing the ends of the steam valve with the usual edge marks. The model, as is readily seen, is accessible on both sides and may be quickly changed from a single-eccentric Corliss gear to either a plain slide-valve or riding-cutoff gear with two eccentrics. The governor hight is adjustable, giving opportunity for the study of the relation of governor hight to point of cutoff, etc.

# Balancing the Thrust in Centrifugal Pumps

## What "Axial Pressure" Is; How It Affects the Devices Designed to Equalize This Thrust, and Why; Best Types of Guide Vane to Employ

BY L. ROEDEL

The theory of the centrifugal pump is comparatively simple, and its design and construction seem to present no difficulties to the engineer, yet anyone who has ever had anything to do with such pumps will admit that it is no easy matter to solve successfully the theoretical and practical problems involved in their production. Aside from the exact calculation of the

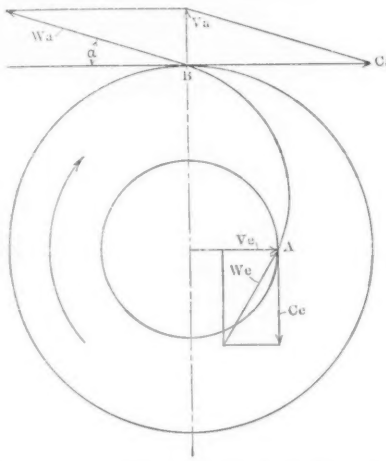



FIG. 1. VANE INCLINED TOWARD THE PERIPHERY OF THE IMPELLER

vane-cell cross-sections for a certain volume and head, the balancing of the thrust, or axial pressure, is the most difficult problem to solve. It has been practically demonstrated that notwithstanding the provisions made by the designer for balancing the thrust on multistage pumps, collar bearings, ball bearings and other devices for equalizing this thrust have been destroyed and the pumps rendered inoperative after a period of satisfactory service, owing to the occurrence of unexpected and excessive axial pressure.

### Axial Pressure

The cause of this pressure may be explained as follows: Owing to the form or curvature of the impeller vane principally in use now, the fluid, during its course through the impeller, alters its absolute velocity and its pressure. They are increased, and the increment of pressure due to the centrifugal force at the outer periphery of the impeller is the cause of this thrust. The magnitude of this increment depends principally upon the contour of the impeller vane, and it is possible to design a vane which eliminates the thrust altogether.

Assuming that the fluid has a radial velocity of $Ve$ (see Fig. 1) and a periphery velocity $Ce$ at the inner periphery of the wheel, then the relative velocity

$$We = \sqrt{Ce^2 + Ve^2} \qquad (1)$$

The energy due to the velocity $We$ is

$$\frac{We^2}{2g} = \frac{Ce^2 + Ve^2}{2g} \qquad (2)$$

During the fluid's course through the wheel, or impeller, $We$ is increased to $Wa$ at the outer periphery, and the energy at that point is equal to

$$\frac{Wa^2}{2g} = \frac{Ca^2 + Va^2}{2g}. \qquad (3)$$

The fluid now leaves the impeller with a relative velocity

$$Wa = \sqrt{Ca^2 + Va^2} \qquad (4)$$

This is, for instance, the case with a vane of the form shown in Fig. 1, inclined toward the periphery of the impeller at an angle $\alpha$.

In this form of vane the absolute velo-

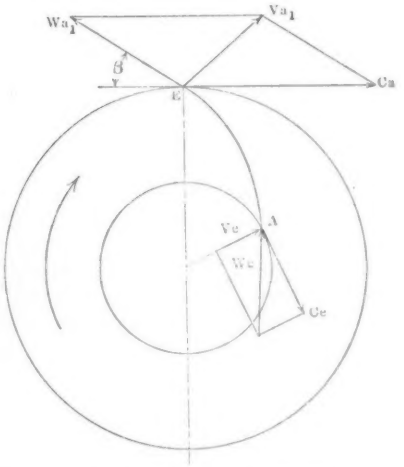



FIG. 2. VANE INCLINED TOWARD WHEEL PERIPHERY

city $Va = Ve$, that is to say, the absolute velocities at the inner and outer peripheries of the impeller are equal; the pressure is also equal, therefore no head can be overcome by the impeller, as the following equation demonstrates:

$$\left.\begin{aligned}\frac{Ca^2 - Ce^2}{2g} - \frac{Wa^2 - We^2}{2g} + \\ \frac{Va^2 - Ve^2}{2g} = 0.\end{aligned}\right\} \qquad (5)$$

It is also evident that in this case the total acceleration, imparted by the impeller to the fluid, has been used to increase the relative speed along the vane from $We$ to $Wa$; therefore, the fluid leaves the wheel in the same condition as it began its course from the inside periphery.

It may now be readily understood that

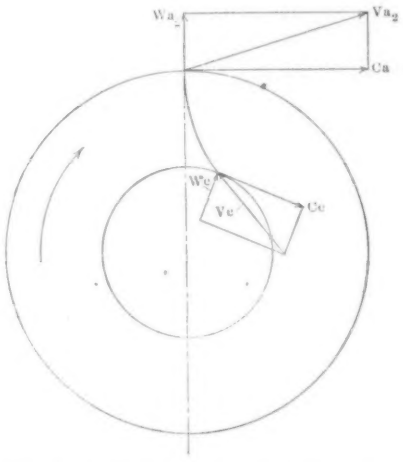



FIG. 3. VANE TERMINATING RADIALLY AT OUTER WHEEL PERIPHERY

the fluid cannot be elevated to any hight after leaving the impeller by a vane so designed, and a vane inclined even at a smaller angle than $\alpha$ would remain passive toward the fluid. In Fig. 2, vane $AE$ is inclined toward the wheel periphery at an angle $\beta$ and as the parallelogram of velocities shows, $Wa_1$ is the relative velocity of the fluid at point $E$. In this case $Wa_1$ is only slightly greater than $We$; according to the foregoing, however, the relative velocity $We$ could have been raised to the magnitude of $Wa$ in Fig. 1, hence it is obvious that a part of the energy imparted to the fluid by the impeller wheel has been utilized to increase the pressure, or static head, as the following equations make clear:

$$\left.\begin{aligned}\frac{Ca^2 - Ce^2}{2g} - \frac{Wa_1^2 - We^2}{2g} + \\ \frac{Va_1^2 - Ve^2}{2g} = Hs + Hd.\end{aligned}\right\}$$

In this equation

$$\frac{Ca^2 - Ce^2}{2g} = Hs = \textit{Static head}$$

and

$$\frac{Va_1^2 - Ve^2}{2g} = Hd = \textit{Dynamic head.}$$

In this case $H\,s$ has a positive value and so has $H\,d$, while in equation (5) $H\,s$ and $H\,d$ cancel, as Fig. 1 graphically shows and equation (5) verifies.

Fig. 3 presents a vane which terminates radially at the outer wheel periphery, and the parallelogram results in a relative velocity $W\,a_2$ equal to the radial component of the actual or absolute velocity $V\,a_2$, usually denoted as radial velocity. In this case the pressure, or static head, becomes greatest, and the relative velocity smallest.

Fig. 4 shows a vane curved in the direction of rotation of the wheel; the velocity diagram indicates that, with an impeller vane so designed, the relative velocity $W\,a_3$ increases, but the static head, or pressure, decreases, and if the vane angle amounts to 180 degrees $\alpha$, then the whole energy imparted by the wheel to the fluid is just sufficient to raise the relative entry velocity

$$We = \sqrt{Ce^2 + Ve^2}$$

to the magnitude of

$$W\,a_3 = \sqrt{Ca^2 + Ve^2},$$

hence no increase of pressure takes place. The diagram shows that $W\,a_3$ and $V\,a_3$, the relative and absolute exit velocities, are the highest in this last case, when other conditions (speed of the impeller and entrance velocity, as clearly shown in the figures) are alike. It can now be seen that the increase of pressure, or static head, is solely a function of the vane curvature. This increment of pressure produced by the centrifugal acceleration, is advantageous in regard to the hydraulic efficiency of the pump, but detrimental to its operation, as it causes leakage and axial pressure, or thrust.

### Balanced Thrust

In pumps with impellers turned back

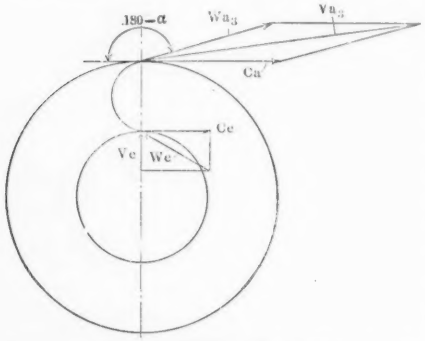



FIG. 4. VANE CURVED IN DIRECTION OF ROTATION OF THE WHEEL

to back, as in Fig. 5, the inner and outer wheel peripheries are separated by means of bushings or packing rings. These rings and bushings are not absolutely tight, and gritty matter contained in the fluid also renders them leaky in a very short time. Between the impeller wheel and diffusion rings there is a clearance from 1/16 to 1/8 inch; therefore, the pressure in space $I$ is the same as in space $A$ at the outer wheel periphery. The first impeller has an unbalanced area, and an axial pressure, or thrust, occurs in the direction of the arrows on the center line. Since both impellers are alike and rotate with the same speed, the axial pressures must be equal; therefore, owing to their symmetrical arrangement, they must bal-

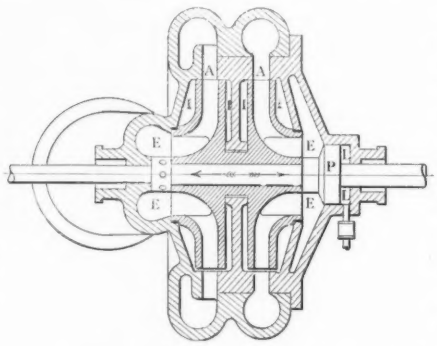



FIG. 5. IMPELLERS TURNED BACK TO BACK TO BALANCE THRUST

ance each other as regards the thrust, and this is clearly shown in Fig. 5.

Fig. 6 represents the most common arrangement of impellers in multistage pumps; the spaces $I$ are separated from spaces $F$ and $E$, so that the areas under pressure are equal; and holes connect spaces $F$ and $E$, so that a thrust cannot obtain. This design has the advantage of simpler and better water conduction in the guide vanes and distance-piece channels.

In the two designs of impeller just described, no unbalanced axial pressure should occur, but in reality this is not the case, as practical experience has demonstrated. The packing rings and bushings, however well fitted, will soon leak, and axial pressure or thrust arises. A very common device to prevent this axial pressure is a balancing piston $P$ keyed to the pump shaft, as shown in Fig. 5. The piston has no packing rings and fits loosely into the recess of the cover; the space $L$ behind the piston is provided with a cock and drain pipe. With the drain-pipe cock closed, the hydraulic pressure on either side of the piston is equal, because the piston, being a loose fit, allows the fluid to fill up space $L$; therefore, by opening the drain cock, the pressure can be reduced to that of the atmosphere. The pressure in front of piston $P$ amounts to half of the total head in the two-stage pump, shown in Fig. 5; the same obtains in space $L$ with closed cock, hence we have a range of equalizing pressure in this case from half the total head to the barometric head—sufficient to balance any thrust which may occur. Of course, this device would require from the operator considerable attention, which is usually not in evidence, nor can it be expected. Although the writer has in mind an automatic device which might be used to operate the drain cock, eliminating especial attention, still he considers this only a makeshift which reduces the efficiency of the pump.

### Forms of Guide Vane

It has been indicated in the foregoing that with the type of vane shown in Fig. 4, no increment of static head is imparted to the fluid during its course through the impeller, the hydraulic pressure at the outer periphery is equal to that at the inner periphery of the wheel, and that spaces $I$ and $E$ need not be separated by means of packing rings or bushings. The impeller wheels can be arranged in that case like Fig. 6, and only the wheel chambers of each stage must be isolated from each other, as shown. This would indeed represent the ideal form of vane, as there is no thrust and the loss by leakage is almost negligible. However, it is a well-known fact that the transformation of the velocity energy of the fluid issuing from the impeller into pressure is accomplished by shocks, which produce losses, and it follows that they increase with the velocity; moreover, it is difficult to design guide vanes which accomplish a satisfactory transmutation of kinetic into potential energy.

The form of vane shown in Fig. 2 imparts to the liquid a certain pressure during its course through the vane cells. In other words, the total centrifugal force, equal to

$$\frac{Ca^2 - Ce^2}{2\,g}$$

$$\left(\text{where } \frac{1}{g} = \frac{1}{32.8} = \text{the unit of mass}\right)$$

is not entirely utilized to accelerate the fluid through the vane cells. Therefore, when it leaves the wheel, it has a certain

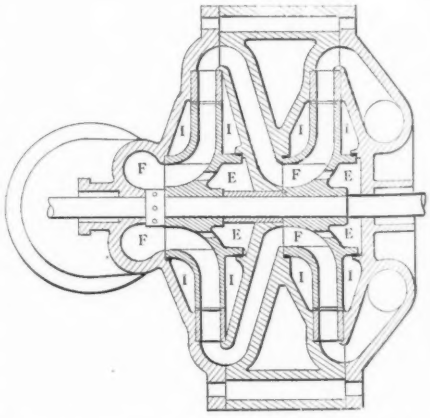



FIG. 6. COMMON ARRANGEMENT OF IMPELLERS IN MULTISTAGE PUMP

static head and also a certain velocity head. But in this case the kinetic energy, due to the absolute velocity, which must be converted into pressure, is much smaller than with the form of vane shown in Fig. 4, hence the former type of vane, Fig. 2, has a greater efficiency than the latter, as has been proved by practical experience.

There are numerous instances, however, where a properly designed forward-curved vane, Figs. 3 and 4, will give better results than the backward-curved type, shown in Figs. 1 and 2, namely, centrifugal pumping plants for low and medium heads such as for sewage-disposal and water-filtering plants, irrigation, dredging, drainage, etc. In such cases the diameter of the impeller becomes the smallest for the forward-curved type, Figs. 3 and 4, assuming equal angular speed for both types of vanes; conversely, the smallest number of revolutions per minute is admissible if the diameter of the impeller is equal for both forms of vanes, which is important for prime movers like steam and gas or gasolene engines.

As the backward-curved vane has shown the best results in general practice, especially for high heads of 60 to 1000 feet and over, and for high-speed prime movers such as electric motors and steam turbines, it is necessary to reduce the thrust to a minimum or eliminate it altogether. The writer suggests the device illustrated in Fig. 7 to balance the axial pressure. In this illustration, $C$ is a cylinder, bored to fit a leather-packed piston $A$, the cylinder being a continuation of the impeller shaft. $P$ $p$ represent a differential plunger fitted and ground into cylinder $B$. Cover $Q$ is tapped for pipe connection with chamber $N$ on the discharge side of the impeller at the second stage. Cylinder $C$ is filled with glycerin or oil and is also provided with a water jacket. The two-stage pump represented in Fig. 7 has two unbalanced areas, one in each impeller, which may be indicated by $I_1$ and $I_2$. If, for instance, a total head of 200 feet, or about 86 pounds pressure per square inch is assumed, or 100 feet, equal to 43 pounds in each stage, then the total axial pressure or thrust, which is to be balanced, amounts to $(I_1 + I_2) \times 43$, and if $I_1$ and $I_2$ each equal 25 square inches, then the total pressure equals $50 \times 43 = 2150$ pounds. Assuming further that the respective notations for the piston and differential plunger $A$, $P$ and $p$ denote their areas, then, according to the laws of hydraulics, we have:

$$\frac{I_1 + I_2}{A} = \frac{P}{p}$$

and

$$p = \frac{P \times A}{I_1 + I_2}$$

or

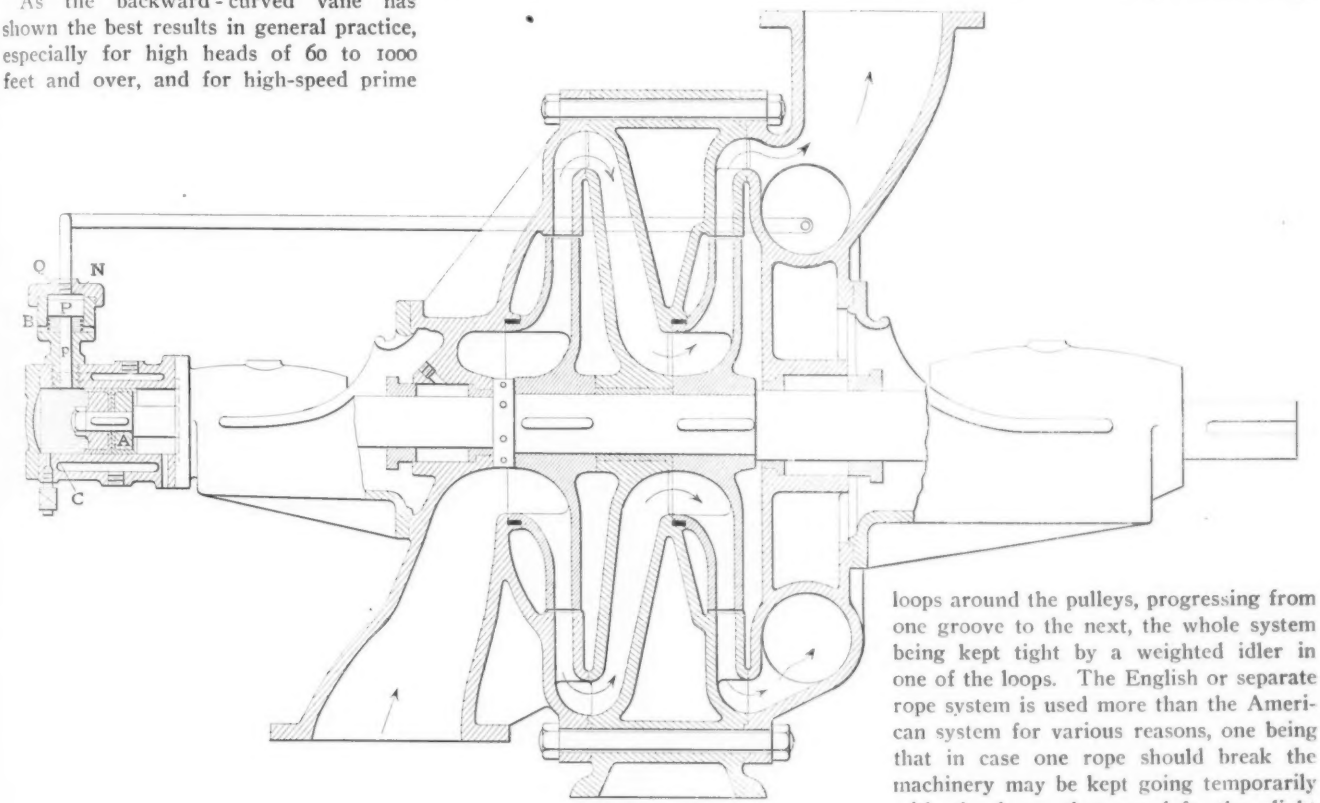



FIG. 7. DEVICE FOR BALANCING AXIAL PRESSURE ON TWO-STAGE PUMP

$$P = \frac{p\,(I_1 + I_2)}{A}.$$

Three quantities are known, and these are the impeller inlet areas $I_1$ and $I_2$, the piston area $A$, and one part of the differential plunger $P$ $p$ may be assumed and the other part determined as previously explained. For illustration, the areas of the different parts may have the following values in square inches: $P = 1.75$, $A = 12$, $I_1 = 25$ and $I_2 = 25$. Therefore

$$p = \frac{1.75 \times 12}{50} = 0.42$$

square inches, and the pressure per square inch in cylinder $C$ equals

$$\frac{1.75 \times 50}{0.42} = 208.333$$

pounds.

## Rope Driving

By Snowden B. Redfield

For transmitting large powers from one pulley or shaft to another, it is often inadvisable to use belting on account of the extreme width of belt and wheel required to deliver the power. For these cases it is usual to transmit the power by means of ropes passing over grooved pulleys; these rope drives being made up of a number of ropes placed side by side. There are two systems of arranging the ropes: First, the English or separate system, in which each rope is complete in itself; second, the American system, in which one continuous rope makes many loops around the pulleys, progressing from one groove to the next, the whole system being kept tight by a weighted idler in one of the loops. The English or separate rope system is used more than the American system for various reasons, one being that in case one rope should break the machinery may be kept going temporarily with the loops that are left, the slight extra strain on these ropes not being enough to injure them.

### Strains on the Rope

In calculating the number of ropes of a given size required to transmit a given amount of power, the allowable pull in each rope must, of course, be known. With a given pull per rope, the amount of power that can be transmitted must depend upon the linear speed of the rope. The following reasoning will make this clear: Suppose that the safe pull for a given rope is 200 pounds, and suppose it is made to travel at the rate of 2000 feet per minute. Then in one minute the work done by this rope would be 200 multiplied by 2000, or 400,000 foot-pounds, and dividing this by 33,000, we have about 12 horsepower.

Now suppose that by using a larger diameter of pulley, turning at the same

number of revolutions per minute, we increase the linear speed of the rope to, say, 4000 feet per minute, keeping the pull in the rope the same. By doing this, we will have performed just twice as much work in a given time, because the rope has traveled just twice as far, and work is the product of force by distance. It may also be considered that by the increase in the pulley diameter we have increased the leverage, and consequently given the rope a better "advantage." With the fact in mind that the faster the rope travels, the more work it can do with a given pull, we naturally expect the question, why not increase the speed indefinitely and thus let one rope do all the work we require, instead of putting in 15 or 20 comparatively slow-speed ropes, as is usually done? To answer this question, we must analyze the matter and find out just what strains come on a rope when used for driving a pulley.

In the first place, when the rope is put on the pulleys and spliced, it must be given an initial tension sufficient to keep it from slipping when transmitting power. Then, of course, there is the useful pull of the rope, or the pull that actually does the work. It is usually assumed good practice to make the initial tension in the rope to keep it from slipping equal to half the useful pull that transmits the power.

These two strains in the rope are obvious at once, but there is a third and very important strain which must be considered. This third strain is that due to centrifugal force as the rope passes at high speed around the pulleys. As already explained, the amount of power transmitted with a given useful pull is directly proportional to the linear speed of the rope. In other words, "twice the speed carries twice the power." However, the matter of centrifugal strain demands attention, for the centrifugal strain increases as the square of the speed, or "twice the speed causes four times the strain."

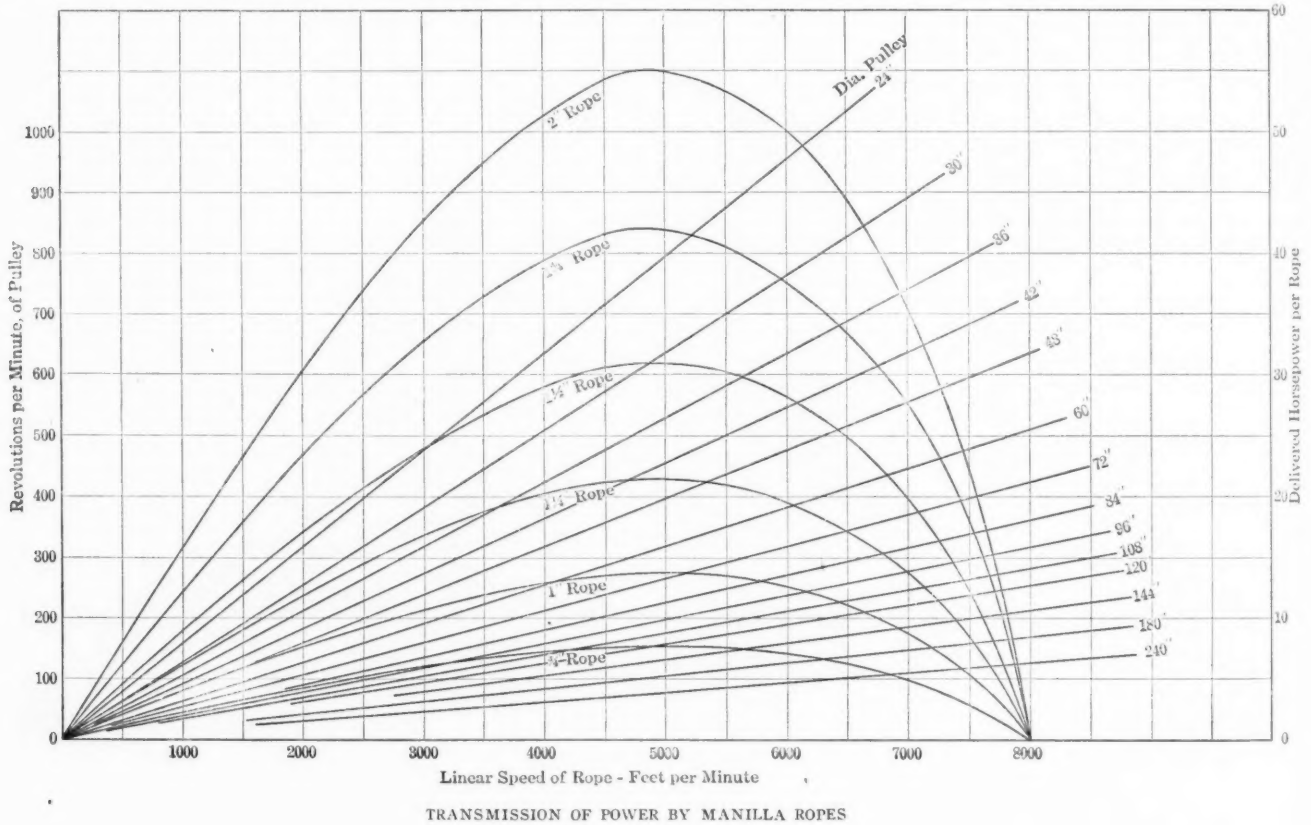
### Net Strength and Speed for Maximum Power

The net strength of the rope available to do useful work must, of course, be what is left after deducting from the total safe strength the strains due to initial tension and the centrifugal force, for the sum of all these strains must not be allowed to exceed the safe working strength of the rope, which is a definite figure for a given size and material. This being the case, it is not difficult to see that, although the power transmitted with a given useful pull is increasing as the speed increases, the centrifugal strain is increasing at a rate so much more rapid that there must be a speed at which the entire safe strength of the rope is being called out to resist this strain of centrifugal force, and there will be no strength available to do useful work. With standard manila rope this does actually happen when the rope is traveling at about 8000 feet per minute.

There are, then, two conditions under which the ropes will not be transmitting any useful work; that is, when the speed is zero, or the rope is at rest, and also when the speed is so great that its entire safe strength is being called upon to resist centrifugal force. Between these two conditions there must be a speed at which a rope of a given material will transmit the maximum amount of power, and with manila rope this maximum efficiency occurs at a speed of about 4800 feet per minute.

### How to Determine Size of Rope

The curves given in the diagram will be found useful for the calculation of rope drives. It is plotted from the standard rope-drive formula for manila ropes, based on a safe total pull of 200 pounds for a 1-inch rope. In the diagram horizontal distances represent the linear speed of the rope, in feet per minute, while at the right side is given the brake horsepower transmitted by one rope. The curved lines show the results for various sizes of rope, and the point of maximum efficiency is very plainly shown for all sizes to be at about 4800 feet linear speed. At the left of the diagram are given the revolutions per minute of the pulley carrying the rope, and the diagonal straight lines give the linear speed of the rim or rope for any number of revolutions, for any diameter of pulley from 24 inches to 20 feet.




TRANSMISSION OF POWER BY MANILLA ROPES

Knowing the safe horsepower capacity for one rope of a given size, the number of ropes required to transmit a given horsepower is easily obtained by dividing this total horsepower by the available horsepower per rope.

As an example, let it be required to transmit 500 brake horsepower, and sup-

pose the pulley is to be 60 inches in diameter, and will run at 320 revolutions per minute. In the diagram find the diagonal straight line marked "60-inch diameter," and follow this down until it crosses the 320-revolution-per-minute line, as marked on the left of the diagram. It will be found that these lines cross at a point corresponding to a linear speed of rim, or rope, of 5000 feet per minute. From the curved lines and the figures on the right of the diagram, it is seen that at this speed a ¾-inch rope will transmit 7¾ brake horsepower; a 1-inch rope will transmit 13¾ brake horsepower; a 1¼-inch rope, 21.4 brake horsepower, etc. To transmit 500 brake horsepower, it will then require 500 divided by 7¾, or sixty-five ¾-inch ropes, or thirty-seven 1-inch ropes, or twenty-four 1¼-inch ropes, or sixteen 1½-inch ropes. The size of rope is determined by the pulley diameter as well as by the number of ropes required. The rope should never be so large that the smallest pulley diameter is less than 40 times the diameter of the rope.

For instance, for 2-inch rope the smallest pulley should not be less than 80 inches in diameter; for 1½-inch rope, 60 inches in diameter; for 1¼-inch rope, 50 inches; for 1-inch rope, 40 inches; for ¾-inch rope, 30 inches. This minimum ratio is not always adhered to when it is more important to keep down the number of ropes than that they should last a long time. The effect of small pulley diameter is merely to cause more rapid wear of the rope. Also, where long life of ropes is not so important as limited space, the allowable horsepower is sometimes increased to double that given on the diagram.

It would be well to remark here that in using the diagram the linear speed of pulley rim or rope is, of course, the same for both pulleys (neglecting any small creep or slip), so it makes no difference which pulley diameter is selected, provided only that the corresponding revolution per minute is used. The diagram is based on conservative practice and pretty closely adhered to by commercial engineers.

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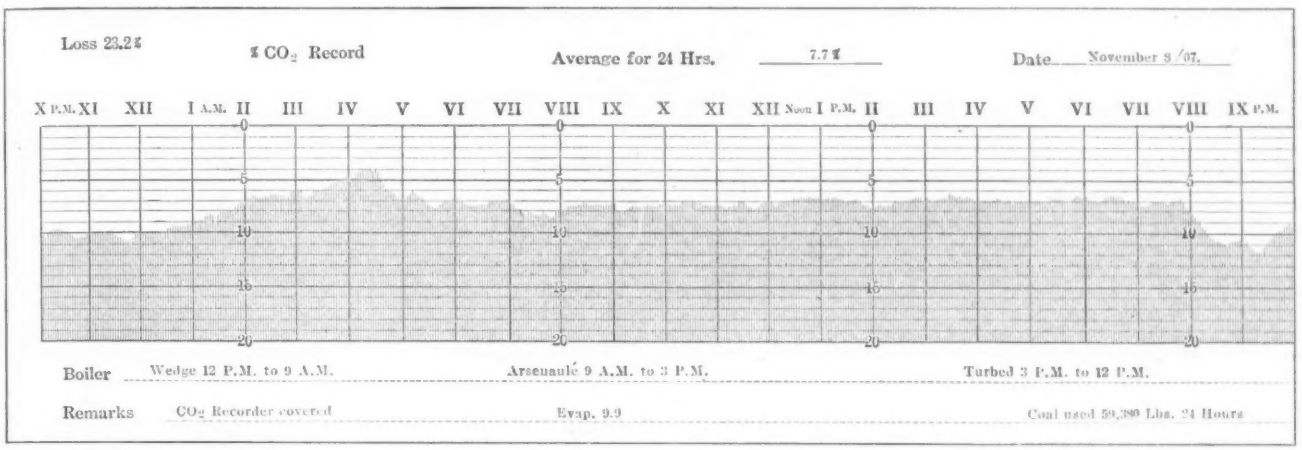
Safe flywheel diameter in feet equals 600 ÷ (3.1416 × revolutions per minute).

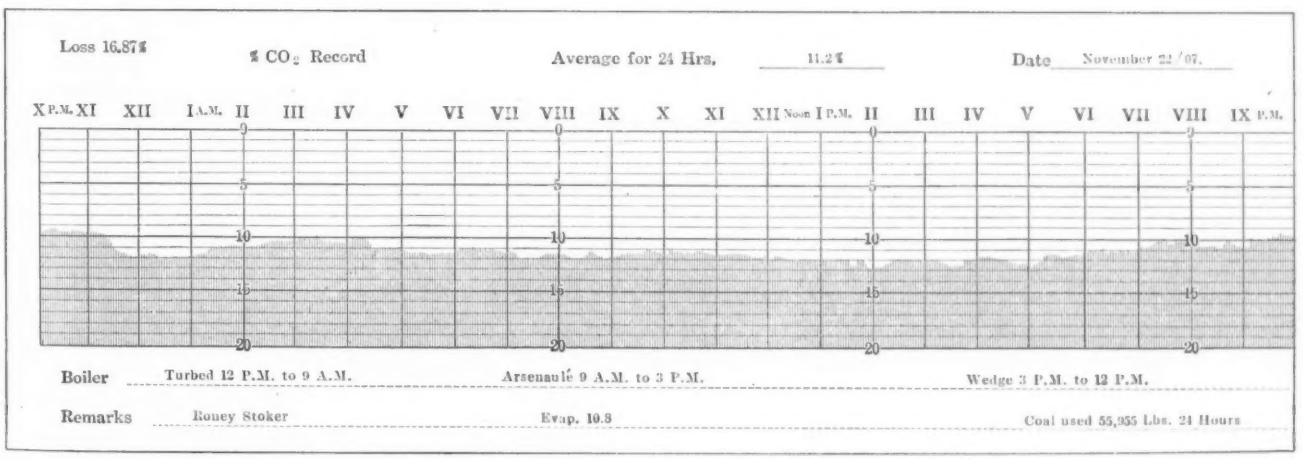
## Coal Consumption and $CO_2$

As evidence of the practical value of a $CO_2$ recorder in the boiler room, the engineer of the Malden (Mass.) Electric Company ran two 24-hour tests on a 500-horsepower boiler fired with a Roney stoker, one with his $CO_2$ recorder covered, so that the attendants were denied the benefits of its readings, and the other with it uncovered. The tests resulted in average records of 7.7 and 11.2 per cent. of $CO_2$, with coal records of 59,380 pounds and 55,955 pounds, the lower coal consumption being attained with the higher percentage of $CO_2$, obtained when the readings of the recorder were available for the guidance of the fireman. The difference is 3425 pounds, which at $5 per ton amounts to $8.50 per day of 24 hours. The charts obtained are reproduced herewith.

Record A


Loss 23.2%
% CO2 Record
Average for 24 Hrs. 7.7%
Date November 8/07.
X P.M. XI XII I A.M. II III IV V VI VII VIII IX X XI XII Noon I P.M. II III IV V VI VII VIII IX P.M.
0
5
10
15
20
Boiler Wedge 12 P.M. to 9 A.M. Arsenaulé 9 A.M. to 3 P.M. Turbed 3 P.M. to 12 P.M.
Remarks CO2 Recorder covered Evap. 9.9 Coal used 59,380 Lbs. 24 Hours

Record B


Loss 16.87%
% CO2 Record
Average for 24 Hrs. 11.2%
Date November 22/07.
X P.M. XI XII I A.M. II III IV V VI VII VIII IX X XI XII Noon I P.M. II III IV V VI VII VIII IX P.M.
0
5
10
15
20
Boiler Turbed 12 P.M. to 9 A.M. Arsenaulé 9 A.M. to 3 P.M. Wedge 3 P.M. to 12 P.M.
Remarks Roney Stoker Evap. 10.8 Coal used 55,955 Lbs. 24 Hours

RESULTS OF TESTS WITH $CO_2$ RECORDER COVERED AND UNCOVERED

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Chicago's department of public works has completed plans for a high-pressure water system, similar to that in New York, which will cost about $2,500,000.

# Power for Making Injectors

By F. C. Shafer

Advancement in power-plant apparatus has been rapid, and in an equal degree has the efficiency increased. These improvements, however, have been utilized mostly in plants devoted solely to the production of power, and not so much in the plants of manufacturing establishments. Until recently the management has not looked upon the power end of the factory to lessen the cost of production and is only now beginning to realize the great saving to be effected by the economical operation of the engines, the complete combustion of the coal, the heating of the feed water, etc. As a consequence, manufacturers are turning their attention to these things and effecting a saving through the power end of the factory.

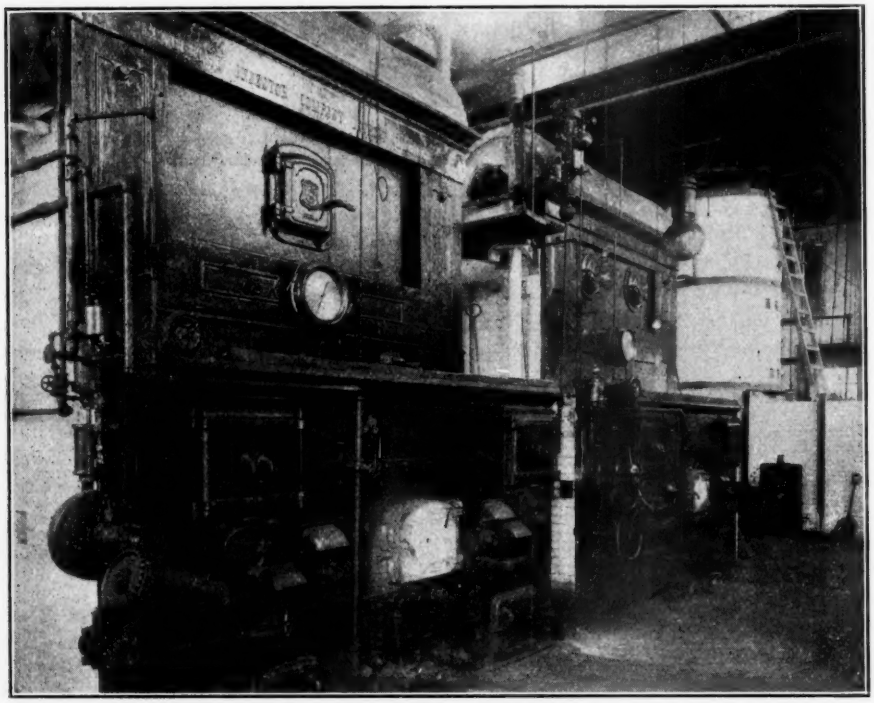

FIG. 1. A VIEW IN THE BOILER ROOM

As an illustration of what is being done along this line, the power plant of the Penberthy Injector Company, located at the corner of Holden avenue and the Grand Trunk Railway, Detroit, Mich., affords an excellent example. Although not of large capacity, it is modern in every particular, and special attention has been given to the distribution of power.

## Boiler Room

The boiler room, shown in Figs. 1 and 2, is 38 feet wide by 60 feet long. It contains four boilers: two Stirling water-tube boilers of 164 horsepower each, one vertical Wickes boiler of 50 horsepower and one Oswego boiler of 25 horsepower capacity. The Stirling boilers, which furnish steam for power purposes only, have drums 36 inches in diameter by 9 feet 6 inches long, and are made of ¾-inch steel, having double-strapped, triple-riveted butt joints, with an efficiency of 87.5 per cent. The Wickes boiler is of exceptional strength, having quadruple-riveted double-strapped butt joints with an efficiency of 94 per cent. of the solid plate. It is designed for a pressure of 300 pounds with a factor of safety of six.

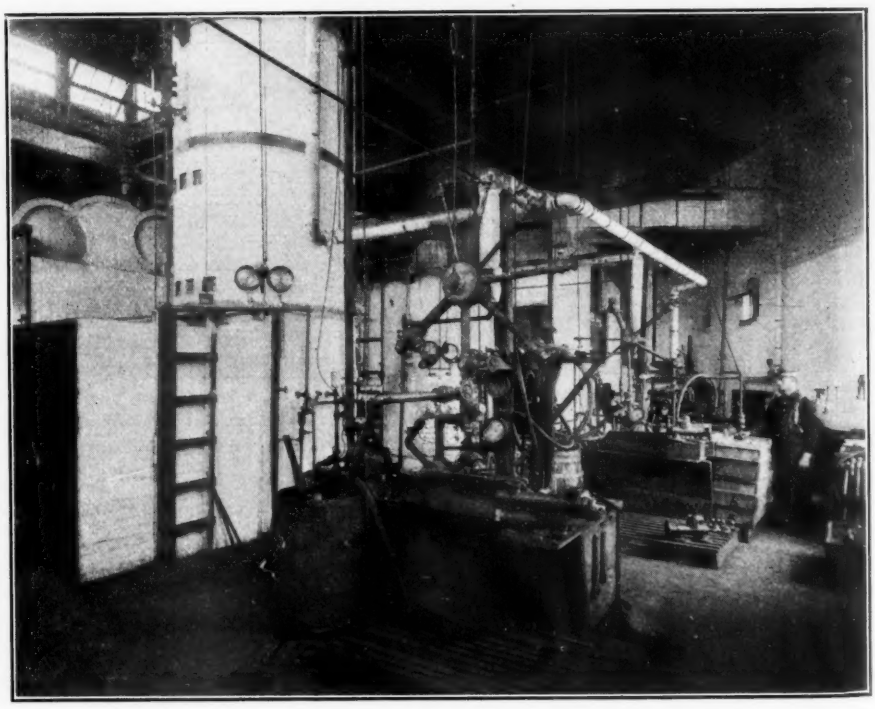

FIG. 2. THE VERTICAL BOILERS AND INJECTOR TESTING RACK IN FOREGROUND

The Stirling boilers, Fig. 1, are equipped with the Murphy automatic furnace, which is capable of handling coal from slack up to stove size. With the furnaces in operation coal is fed from the sides into a magazine, at the bottom of which is a coking plate. Against this plate the grates have their upper support, and from this point slope down to the center. The grates are in pairs, one fixed and the other movable, the movable grate being operated by a rocker bar at its lower end. The exhaust steam from the stoker engine escapes on either side of a clinker grinder and helps to eliminate the cinders by softening them. The boilers are equipped with the Success automatic water gage, manufactured by the Penberthy company, and are fed by injectors which operate against a pressure of 150 pounds.

The two vertical boilers, shown in Fig. 2, furnish steam for the three testing racks in the foreground. The boiler at the left is of Wickes make, 48 inches in diameter and containing 68 tubes. The other is the Oswego boiler, carrying 186 pounds pressure. At the present time bituminous coal of stove size is being used.

Something out of the ordinary for a plant of this size is the fact that two stacks are provided for furnishing the draft; a steel stack 110 feet high by 48 inches in diameter and a brick chimney 36 inches square by 90 feet high. At the back of the boilers is the feed-water heater, which is of 250 horsepower capacity, delivering feed water to the boilers at 208 to 212 degrees Fahrenheit. Compound is fed into the feed water and the boilers are cleaned about once a month. The main header is 6 inches in diameter. All piping is made extra heavy, being designed for 300 pounds pressure, and is insulated with 85 per cent. magnesia covering.

### Engine Room

Fig. 3 shows the engine room, which is 24 feet wide by 45 feet long and contains one direct-connected unit, a four-panel switchboard and a small rotary converter. The engine is a Buckeye tandem compound rated at 153 horsepower, with dimensions of 10x17½x18 inches. The speed is 200 revolutions per minute, and is regulated by an inertia governor. The engine drives a Western Electric generator of 400 amperes and 250 volts.

Cards are taken regularly from the engine and its operation watched with the greatest care. The exhaust steam is used for heating the entire factory, which is equipped with the Webster system.

### Power Distribution

In the factory the machinery has been arranged in groups, having one motor per group, and in this way great saving has been effected over the old belt transmission. A feature of interest is the automatic safety stop on the engine. Buttons have been provided in all parts of the plant, by which, upon a minute's notice all machinery can be stopped. The factory is also equipped with the Niagara sprinkler system for fire protection.

Taken in all, the plant is an excellent example of what modern manufacturers are doing in order to meet competition, and their efforts in this direction are being rewarded beyond expectation.

## The Waste Heat of the Gas Engine

By Cecil P. Poole

The fact that a gas engine utilizes only 20 to 30 per cent. of the heat in the fuel has inspired repeated suggestions of means for turning the rejected heat into work. Most of these involve a combination of steam and gas power, the predominating (and spontaneous) idea being to evaporate the water discharged from the gas-engine jacket and use the steam to drive another prime mover. This idea is highly attractive on paper and its application is perfectly practicable, but I have never been able to devise a combination, even on paper, which seemed promising from the vulgar viewpoint of dollars. The combination of gas engine and steam turbine suggested by H. G. Stott two years ago would have the advantage of increased flexibility as compared with a straight gas-power plant, but no other attraction.

There are available three logical methods of utilizing the waste heat of gas engines for driving steam units: To heat all of the jacket water with the exhaust gases, evaporate it into high-pressure superheated steam by means of coal-fired boilers, and use the steam in engines or turbines; to follow the same course, but fire the boilers with gas taken from the same producers which supply the engines; and to make and superheat as much steam as possible with the exhaust gases alone, using the steam in a low-pressure turbine. The first method would entail either the operating disadvantage of using two kinds of coal in one plant, one kind for the boiler furnaces and another for the gas producers, or else the use of unnecessarily expensive coal under the boilers. This will disappear when a successful induced-draft bituminous producer becomes available. The second method necessitates the use of gas producers of about 4⅓ times the capacity required by the gas engines alone. The third method is open to the objection that it does not provide sufficient additional output to make it worth while in any but very large plants.

Disregarding the question of commercial advisability based on the complete proposition, it is interesting to consider the fuel and output results of the three combinations just described. For the purpose of such a comparison the following preliminary data are assumed:

| | |
|---|---|
| B.t.u. per pound of coal | 12,500 |
| Producer efficiency | 80% |
| Coal-fired boiler efficiency | 70% |
| Gas-fired boiler efficiency | 80% |
| Exhaust gas boiler efficiency | 83% |
| Feed-water heater efficiency | 85% |
| Gas engine efficiency (brake) | 25.45% |
| Exhaust gas temperature, absolute | 1600 deg. |

Gas-engine heat balance; one brake horsepower-hour:

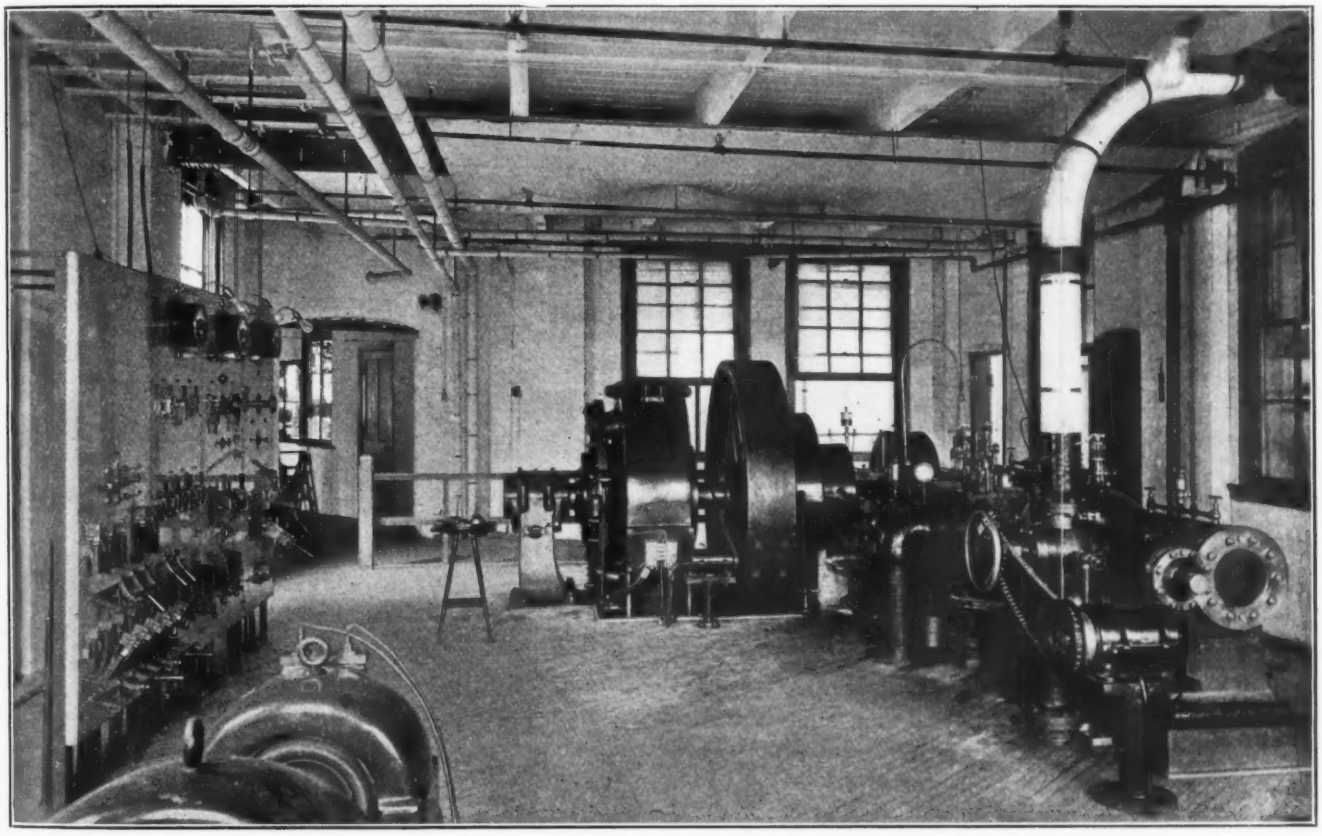

FIG. 3. MAIN GENERATING UNIT AND SWITCHBOARD

| | B.t.u. |
|---|---|
| External work | 2,545 |
| Exhaust gases | 3,800 |
| Jacket water (35 lbs. raised 85° in temperature) | 2,975 |
| Friction | 450 |
| Unaccounted for | 230 |
| | 10,000 |

Ignoring stand-by losses, the rate of coal gasification would be one pound per brake horsepower-hour at full load.

### Gas Plant and Complete Steam Plant

Taking first the combination of gas-power equipment and a straight coal-burning steam plant, assume that the boilers deliver superheated steam, that the gas-engine jacket water enters at 65 degrees and is discharged at 150 degrees, and that it is raised to 210 degrees by the exhaust gases in a closed heater. Then the following heat and fuel results will be obtainable per brake horsepower-hour of gas-engine output:

Heat to heat and evaporate 35 pounds of water from 210 degrees to steam at 175 pounds absolute pressure = $1016.2 \times 35 = 35{,}567$ B.t.u.
Heat in the coal fired $= 35{,}567 \div 0.7 = 50{,}810$ B.t.u.
Steam coal fired $= 50{,}810 \div 12{,}500 =$ 4 lbs.
Heat to raise feed water from 150 to 210 degrees (taken from exhaust gases) ..... .u
Quantity of *available* heat in exhaust gases, between 1600 and 670 degrees, absolute ..... 2,210 B.t.u.

A steam turbine, with good vacuum, will probably deliver a brake horsepower-hour on 14 pounds of steam under ordinary operating conditions. The turbine output, therefore, per brake horsepower of gas-engine output would be 2½ brake horsepower, and "utilizing" the waste heat from the gas engines would entail burning 4 pounds of steam coal and 1 pound of producer coal to develop 3½ brake horsepower, while the same output could be had for 3½ pounds of coal in a straight gas plant and the complexity of two complete power plants of different types avoided. At $3 for the steam coal and $4.80 for producer coal the fuel cost would be exactly the same per unit of output for a straight gas-power plant as for the composite plant. In localities where good steam coal can be bought for $3, however, pea coal does not cost as much as $4.80 per ton.

### Gas-fired Steam Plant

The results with gas-fired boilers for the steam plant are much less favorable:

B.t.u. to evaporate the water = ..... 35,567
B.t.u. required in the fuel gas = $35{,}567 \div 0.8 = 44{,}460$
Total coal fired in the producers = $(44{,}460 + 10{,}000) \div 12{,}500 =$ 4.4 lbs.

The fuel cost per total brake horsepower, therefore, would be 76 per cent. higher than in the preceding case, on the basis of the coal prices given, and the plant would be much more costly because of the larger producer equipment.

### Low-pressure Steam Turbine

Considering the third method, it is assumed that the exhaust gases pass first through a superheater and then through the boiler; that the jacket water enters the jackets at 65 degrees Fahrenheit and issues at 150 degrees; that it is carried directly to the boiler and evaporated into steam of 4 pounds absolute pressure, which is heated 50 degrees by the superheater. No feed-water heater is required because the discharged jacket water is within 3 degrees of the temperature of the steam.

The following figures are based on the foregoing and preliminary assumptions:

Heat required to superheat 1.6 pounds of dry steam 50 deg. .. 40 B.t.u.
Heat taken from gases by superheater ..... $= 40 \div 0.833 =$ 48 B.t.u.
Temperature of gases leaving superheater =

$$1600 - \frac{48 \times 1600}{3800} = 1579.8 \text{ deg.}$$

Heat required to evaporate 1.6 pounds of water ..... 1616 B.t.u.
Heat taken from gases by boiler = 1939 2 B.t.u.
Temperature of flue gases, absolute,

$$1579.8 - \frac{1939.2 \times 1579.8}{3800 - 48} = 762 \text{ deg.}$$

This does not use up all the heat available in the exhaust gases, but it would not be practicable to maintain such perfect equilibrium between the different parts of the plant as to do this regularly, and the margin of about 100 degrees in the flue gases is left for "coming and going." The quantity of steam assumed (1.6 pounds) would doubtless produce 0.06 of a horsepower at the turbine shaft, and the maximum turbine output would therefore be 6 per cent. of the gas-engine output. Obviously, the plant would have to be a fairly large one to supply sufficient surplus heat to run a turbine of ordinary output, and the turbine would not be able to handle the peak load in a station of average load characteristics.

### Low-pressure Gas Turbine

The most attractive scheme, however, is that of a gas turbine to take the exhaust gases from the engine. This was not included in the methods enumerated at the beginning of this article because, unfortunately, it is not yet available. Should such a turbine be developed, there is no reason to doubt that its thermal efficiency would be somewhere around 14 to 16 per cent. With only 12 per cent. efficiency, however, a gas turbine applied under the conditions stated would yield 0.18 brake horsepower for each brake horsepower of full-load engine output, or about three times as much as the low-pressure steam turbine, and the only additional plant equipment would be the turbine itself.

### General Conclusions

The foregoing rough analysis, taking into consideration only the relative output and fuel economy at full load, does not, of course, serve as a reliable guide as to the relative merits of the different schemes when considered completely as commercial propositions; that was not the intention. It serves, however, to indicate the fallacy of assuming that the waste heat from a gas engine is all available for power purposes "somehow." The heat in the exhaust gases can be utilized only above the temperature limit imposed by the character of the work. It sounds extravagant to talk about "throwing away" 3800 B.t.u. in the exhaust per brake horsepower-hour of output, but if one attempts to make steam or superheat it with the exhaust heat, less than 60 per cent. of it can be used, because of the high temperature of the steam, and the large proportion of heat rendered latent in evaporation reduces the resultant available energy to a pitiful proportion.

### Hot-water Heating

Until an efficient low-pressure gas turbine is developed, it would seem that waste heat from gas engines can be most profitably applied to heating. A hot-water heating system as an adjunct to a gas-power plant could easily utilize between 60 and 70 per cent. of the exhaust heat and all of the heat in the discharged jacket water; such an auxiliary system would bring the gas engine nearer to the steam engine in applicability where sensible heat must be supplied by the power plant. There would still be the drawback, however, that a gas-power plant would not furnish as much heat as a steam-power plant of the same output. For example, with 35 pounds of jacket water per brake horsepower-hour discharged at 140 degrees Fahrenheit, and the exhaust gases containing 3800 B.t.u. at 1600 degrees absolute temperature, the following figures are obtained for the gas plant:

Heat to raise 35 lbs. of water from 140 to 190 degrees Fahrenheit = ..... 1750 B.t.u.
Heat taken from the gases = $1750 \div 0.85 =$ 2059 B.t.u.
Temperature range of exhaust gases in the heater = ..... $1600 - 655 =$ 945 deg.
Heat available in gases = $3800 \times 945 \div 1600 =$ 2244 B.t.u.
Heat rejected by heater ..... 185 B.t.u.

Assuming that the water was cooled in the radiating pipes to 70 degrees Fahrenheit, the heat units delivered in sensible heat to warm the building would be 4200 B.t.u. per brake horsepower-hour of engine output at full load.

A noncondensing steam engine of high efficiency will easily furnish 25,000 to 26,000 B.t.u. per brake horsepower, in the latent heat of evaporation contained in the exhaust steam. This is obviously about six times as much heat as the gas engine could supply. However, a condensing steam engine can supply no heat whatever, while the gas engine is able to supply about 4000 heat units per brake horsepower-hour and do the same amount of work, with a consumption of only one-third the quantity of fuel.

Notwithstanding the usual plausible argument to the effect that if a boiler must be put in to get steam heat one may as well go the whole length and put in a steam plant for both power and heat, a producer gas-power plant, with a small heating boiler if necessary, offers advantages in fuel economy and cleanliness which cover a multitude of sins—excepting shutdowns.

# Firing Stationary Boilers Economically

## Instructions and Suggestions on Methods of Firing, Regulation of Air Supply; Cleaning, Kindling and Banking Fires, and Smoke Prevention

BY F. R. WADLEIGH

The question of economy in the use of fuel is being given more attention at the present time than ever before, and the writer's attention has often been called to the lack of any detailed instructions on firing stationary boilers which would be of practical use at any hand-fired steam plant using coal as fuel. It is true, of course, that such instructions must necessarily be more or less general in character, owing to the great diversity of boiler conditions, but at the same time there are certain fundamental rules for firing which will apply everywhere, and enough details and suggestions can be added to enable most of the necessary differences in conditions to be covered and provided for.

It should be noted that the instructions to follow apply more particularly to Eastern coals and steam plants, as they are more needed in the East than in the West, where the average intelligence of the firemen is higher, as is also their pay, and where more attention is paid to fuel economy and firing, partly because the Western coals are inferior and need more careful attention and partly because coal is cheaper, on the whole, in the East. The writer offers, therefore, the following suggestions and instructions for firing stationary boilers, with the hope that they will be of some value to everyone concerned in the management of the average hand-fired steam plant. Criticisms are expected, and indeed asked for, as the subject is one that will admit of different views and opinions.

### Boilers and Boiler Rooms

The kinds of boiler used and their equipment are things about which the fireman hasn't much to say and he usually has to take them as he finds them. But the fireman of intelligence who tries to learn about such things may sometimes have not a little to do with improving the boiler-room conditions. He can, at the expense of a little trouble and time, usually find out what other plants are doing and what kind of equipment they have that is better than he has, so that he can talk intelligently about such things to his engineer or superintendent when he has the chance, and show them, possibly, why or how their plant could be improved. And this is not theory, but what the writer has actually seen occur at some plants.

This is one way by which the fireman cannot only improve himself, but actually make his work easier. There is another thing that the fireman should never fail to do for his own protection as well as that of his employer, and that is to report at once to the engineer or his immediate superior any defect that he may find about the boilers. Defects of any kind about boilers should never be allowed to go without attention. They always mean a loss of fuel in some way, and if allowed to go may be dangerous.

### Cleaning Boilers

The great importance of keeping clean all heating surfaces, both inside and outside of the boiler, should be impressed on the minds of everyone connected with the steam plant. This is a matter too often neglected at the small steam plants and often at the large ones, and this neglect is always the cause of waste of fuel, lack of steam and very often of damage to the boiler and sometimes of serious accidents.

The fireman should remember that failure to clean at the proper time the flues, boiler and combustion chamber and the dust that may collect at the bottom of the stack means that he will have to handle more coal and that it will be harder for him to keep up steam. As to the proper times for cleaning, these will vary according to conditions at different plants, the kind of coal and the water used for the boilers, etc. But after the best times for the various cleanings have been found out, they should be strictly adhered to and no excuse taken for failure to do the work. The steam-plant owner should realize, although many of them don't seem to, that the boiler room is the place where more money can be saved or wasted than in any other part of his plant.

If you have a good fireman, give him the best tools to work with and he will become still better. If you have a poor fireman, give him good tools and he will also do better work. It would undoubtedly be money well spent to have boiler rooms built with some regard for the comfort of the men who work in them. They should be properly ventilated, and all steam pipes, etc., covered with some nonconductor of heat, and all steam leaks stopped as soon as they appear. Every properly built boiler room should also have a sink and water connection for the use of the firemen.

There is no reason apparent why the engine- and boiler-room force should not have well ventilated rooms and toilet arrangements as well as the clerks in the office. The former have much harder and much more important work. It is easy enough to get a good or a sufficiently good $60 per month clerk, but it is very difficult to get a first-class fireman, and the plant owner should be willing and glad to do as much at least for the comfort of the latter as for that of the former, especially as the latter is the only one of the two that can actually make money for the plant. Another thing that will add to the comfort and lessen the labor of the fireman is having a level, hard boiler-room floor that the shovel will slide over easily. This is often overlooked in the average steam plant, yet there is nothing more unpleasant in firing than to have a floor full of holes and bumps.

### Coals Used

As every intelligent fireman knows, there may be considerable variation in the quality and heating value of not only different kinds of coal, but of different lots of coal from the same coal seam. At a plant where one kind of coal is always used, the fireman gets accustomed to handling that coal and should learn exactly what he can do with it, how much to put on the fire at a time, how often to fire, and when the fires must be cleaned. But where it is the custom, as at many plants, to buy several different kinds of coal during the year, the fireman must learn the peculiarities of each kind and should be able to tell just why one kind will do better work than another, why one will burn faster and make more smoke, while another will not burn so fast, but will make more clinker or more ashes and so on. No definite instructions can be given as to the best way to burn the different kinds of coal, as so much depends upon the equipment of the plant, the demand on the boilers for steam, the draft, etc.

Fuel and its use are the vital factors in the cost of production at every steam plant. The cost of fuel may average as high as 50 per cent. of the total cost of producing power, and the man with the shovel has more to do with the final cost than any other one employee. The fireman should look upon the coal as so much money entrusted to his care by his employer to be used in the most careful and intelligent way and from which he is to get the most returns. Conversely, however, the employer should realize that

for all practical purposes the fireman is the man who handles the money value of his coal, and he (the employer) should do all he can, for his own advantage, to assist the fireman in using the coal so as to obtain the most efficient results from it.

### Impurities in Coal

It is surprising to see how little is known by engineers and firemen regarding the various impurities found in coal and their effect on the fire. Yet it is an easy matter for them to learn the appearance of most of the impurities found and such knowledge will always lessen their labor, as by throwing out the slate, etc., they will get better results and the work of cleaning fires will be made easier. An instance of the lack of this knowledge occurred a short time ago, when the writer was requested to examine a pile of coal, slate, etc., of about one-half ton, which had been thrown out by the fireman and engineer at a large steam plant as having no fuel value and being unfit to burn. A careful examination of the pile showed that about three-fourths of it was perfectly good coal, as was afterward proved by burning it, but owing to some of it being water stained and made more dense than the ordinary coal by crushing and "slips" in the mine, it had a dull, slaty appearance. Yet the engineer in this case was a man who had had about 20 years' experience and the fireman had been handling coal for 8 or 10 years, and had been using the same kind of coal as examined for three or four years.

The fireman then should learn the appearance of the various impurities in coal and should watch the coal closely for them, throwing out such as he sees. He should learn by experiment the effect that the impurities have on the fire, whether they will make a running clinker or merely add to the amount of ash, etc.

### Size of Coal Used

Whatever the grade of coal used, no lumps larger than a man's fist should be put on the fire, as a large lump retards combustion and makes a bad spot in the fire. Coal should be broken and used in as nearly uniform size as possible. If run-of-mine coal be used, the lumps and slack should be mixed together before firing, so as to give the greatest possible uniformity in burning. It is impossible to keep a level fire without using the hook, if large lumps are put on the fire mixed with small coal.

### System and Regularity

The value of system and regularity should be strongly insisted on in the work of the fireman. The engineer in charge of every plant should work out a system for the work of his boiler room, including the method of firing to be used, the thickness of fires to be carried, the regulation of the feed water, blowing out boilers and gages, testing the safety valves, cleaning fires, cleaning ashpits, blowing out flues, breaking up coal, regulation of the draft, unloading and bringing in coal, etc. After working out the best system for his plant, he should see that it is carried out and that each man in the boiler room understands exactly what he is to do. In this way, it is believed that better results will be obtained and that the actual labor of the men will be lightened.

### Boiler-room Records

As an aid to systematizing the work in the power plant and in order to enable the owner or manager to know exactly what results are being obtained each day, there should be daily records kept of the various items of the day's work to include, for the boiler room: Boilers used, number and kind; safety valves tested, time; boilers blown out, time; flues cleaned, time; fires cleaned, time; coal unloaded, if from cars, give car number; kind of coal; weight of coal as used; average steam pressure; amount of ashes and clinkers taken out; amount of water used, and temperature of the feed water, which should be taken every hour. Other records should also be kept, pertaining more especially to the engine room, the electrical output, indicated horsepower, vacuum, etc. Keeping all these records may seem to involve considerable extra work and some expense, but no engineer will deny that they are not valuable and, in fact, necessary, if it is desired to know each day what is going on in the power plant.

The fact that records are kept and followed up is of itself an incentive to the firemen to do more careful work and to see if they cannot improve on their records from time to time. It has also been found, in the writer's experience, that an investigation into the cause of some unexpectedly poor showing has led to the discovery of either better methods or of a leak of some kind, neither of which might have been found without attention having been called to them by the daily records.

### Grates

Whatever kind of grate may be used, their condition and the way in which they are put in have much to do with the amount of fuel used. The fireman should see that the air spaces are kept open, that the grate bars fit properly, both next to the walls and to each other, and that badly warped bars are not allowed to remain in the furnace. It is a common thing at the average small steam plant to see small heaps of partly burned coal in the ashpit, due to the grates not fitting properly or being warped or to the bridges between the air spaces being broken. When using the slice bar the fireman should be careful to avoid damaging the grates.

If ordinary shaking grates are used, the following rules should be observed:

After shaking the grates be sure that they are put back in their place, otherwise they may project into the fire and be burned or broken by the hook or slice bar and thus allow partly burned fuel to fall through.

It is always better to shake grates a little at a time and more often than to shake them hard and not so often. If too long a time is allowed to elapse before shaking, clinkers may form over the grates so large that they will not go through when the grates are moved. If the fire is allowed to become clogged up with ashes and clinkers and then the grates are shaken violently for two or three minutes, the advantage of the shaking grate is destroyed, its object being to keep the fire clear of ashes and not to allow clinkers to form in large pieces. Handling of shaking grates depends largely, however, upon the kind of coal used, the amount of ash which it contains and the extent to which the ash will clinker.

As to the use of shaking grates as compared with stationary, this may be said: With some coals their use is a necessity; with any coal their use by the average fireman may cause a loss of some coal, due to careless handling, but with ordinarily careful handling, the writer believes that they will show a gain due to better combustion on account of the freer air supply, less opening of doors and not so much loss of heat through cleaning the fires. If properly handled, they should also lessen the work of the fireman, making the cleaning of fires less trouble, as cleaning will not have to be done so often, and will take less time.

### Ashpits

Ashes should never be allowed to accumulate to any extent in the ashpits, and the latter should be kept full of water. This will keep the grates cooler on the bottom as well as make it cooler for the fireman. It is also thought to keep clinkers from adhering to the grate bars, to some extent.

### Draft and Dampers

The necessity and importance of having good draft under boilers is not always understood nor appreciated by the steam-plant owner. Many complaints of poor coal, no steam, burnt-out grates, overworked firemen are caused by lack of sufficient draft to burn the fuel properly, and it is probable that there would be more plants using mechanical draft if this fact was understood better. There is always a certain draft for each kind of fuel and rate of burning that will give the best results, and the fireman should try to find out what amount is needed at his plant to keep up steam with the least amount of fuel. At many smaller plants it is a question of getting enough draft

at any time, but where the draft is ample it should be regulated to suit conditions.

What is needed is enough draft to overcome the resistance offered by the bed of coal to the passage through it of sufficient air to burn the fuel to the best advantage. This does not mean that the strength of draft and the amount of air supplied mean the same thing. Nearly twice as much air is required to burn anthracite as to burn wood, but wood can be burned with about one-fourth of the draft necessary for anthracite.

The fireman should know that the place to regulate or shut off draft is by the stack damper and not by the ashpit doors. For instance, when it may be necessary to shut off draft to keep the steam pressure down, the damper should be closed and not the ashpit doors. The latter are for the purpose of regulating the air supply.

Where the load on boilers varies from time to time owing to the nature of the work, it often becomes necessary to check combustion. Now in order to keep down smoke the fireman should not only not fire so much coal, but he should decrease the amount of draft also to a point where no more smoke shall be made than when the boilers are worked at usual capacity. To do this, however, may require the partial closing of the ashpit doors in addition to closing the damper. The latter should not be entirely closed under such conditions, as some air must be supplied to burn the gases from the coal.

Where mechanical draft is used, the amount of draft is usually governed by the speed of the fan and the demand for steam. Where a plant is equipped with automatic damper regulators, the opening and closing of the dampers is controlled by the amount of steam pressure. But at such plant, the engineer and fireman should find out, by experiment, as nearly as possible, the proper amount of damper opening at the maximum steam pressure, as it may not be necessary to have it open wide under working conditions.

The use of the door grids or registers in the furnace doors is not given much attention in this country, although in England and Germany they are always carefully watched. Many of our boilers will be found not equipped with them at all. Their proper use, however, is conducive to fuel economy and smoke prevention, although in this country the openings are so small that not much air can get through them. In Germany and England the openings are as much as 4 inches per square foot of grate surface, but with a perforated inner door plate to distribute the air. Where used, they should be opened when the door is closed after firing, and closed when the smoke and gases have been distilled from the coal.

Air leaks in the boiler setting and breeching have their effect on the draft and air supply and consequently on the amount of fuel used and the work of the fireman. Under certain conditions a small leak may help combustion, but usually air leaks mean a loss of heat in proportion to their size. In any case, it is better to have them stopped up as soon as discovered.

### Air Supply

The supply of air needed depends upon the kind of coal, the condition of the fire and the amount of coal to be burned; the exact amount needed can only be found out by making analyses of the gases. There is no doubt that the equipment of every plant of any size with one of the devices now on the market for analyzing the gases would result in greater fuel economy and in the use of fuel, better firing methods, as well as increasing the knowledge of the fireman. About the only thing that the fireman can do is to find out for himself by what arrangement of the dampers and doors he can keep up steam easiest with the least amount of fuel and smoke, under all conditions. This, however, is quite enough to keep him busy and to require his close attention.

### Thickness of Fire

It is impossible to give any rule for the thickness of fire to be carried that will apply to all cases, and it is a matter about which there is considerable difference of opinion. The kind of coal burned, the amount of draft, the rate at which the boiler is being worked, the skill of the fireman and the design of the furnace are all factors that must be considered. It is believed, however, that a thickness of from 6 to 8 inches will be found the most satisfactory and economical in the majority of cases. With slack coal and large grate surface the fire should be thinner than with lump coal or run-of-mine.

With poor draft a lighter fire should be carried than where the draft is strong. With a high rate of combustion, that is, when a large amount of coal is being burned per hour per square foot of grate surface, thicker fires must be carried. The unskilled fireman will not do as well with a light fire and will not be able to keep up steam evenly until he has learned to keep the fire level, whatever the thickness of the fire may be.

Where several furnaces discharge into one stack, it is important that the fires in such furnaces be kept at the same thickness. If this is not done, the thin fires will, of course, burn out first and lower the efficiency of the boilers above them.

When estimating the thickness of a fire, allowance should be made for the slope downward of the grates at the back of the furnace, and at this point the fire should be thicker than in front (unless when using the coking method of firing), otherwise it will be difficult for the fireman to tell how much fire is over the grates at that point. It should also be remembered that there are generally more ashes and clinkers next the bridgewall, so that the actual thickness of live fire there may not be so great as it would appear to be.

### Methods of Firing

There are three methods most commonly used in firing stationary boilers: the coking, the alternate and the spreading.

*Coking Method:* Having moistened the coal, fire the fresh coal near the door and across the furnace. After it has given off its volatile matter or gases, push the coal with the hook or scraper to the back end of the grates, where it will make a white, bright fire, with little or no smoke. The back of the furnace should be kept at a white heat all the time. Then when more coal is needed, fire again at the door, allowing the gases from the freshly fired coal to pass over the bright fire at the back, where they will be burned.

With this method some amount of air should be admitted above the fire to prevent the formation of carbonic-oxide instead of carbonic-acid gas. It is also very important to keep a good supply of fire over those places in the grates where the fire tends to burn out fastest, so as to keep holes from burning through and admitting too much air.

While fairly successful with some coals and some types of boiler and furnace, this system is not much used today, because it requires a good fireman to get results. It requires much closer watching of the fire and steam gage than the average fireman is likely to give, and a serious objection is that it requires entirely too much stirring of the fires and consequently loss of fine coal through the grates and an increase of any tendency the coal may have to clinker. Moreover, when a boiler is overloaded or an effort is being made to develop its maximum capacity, this system will not give the results that spreading the coal will, as the gradual distillation of gases takes too long. The method also requires more frequent opening of the furnace doors, which is a serious objection.

*The Spreadnig System:* This is probably the one most in use especially by the unskilled, careless and ignorant fireman. It will give excellent results, however, when properly used and is the best method under some conditions. Fire from two to six shovelfuls at a time, depending on the size of the grates, scattering the coal well so as to spread it evenly all over the grates, especially where the fire is thinnest. The fire should be kept nearly level, but a little heavier along the sides and at the bridgewall. "Take care of the back and sides and the middle will take care of itself," is a good rule with this method. The objection to this system of firing is that the fireman is apt to put too much coal on at a time, and cover the fire too heavily

with green coal, giving him more time to sit down and rest. The fire is then likely to burn in holes and in allowing too much air to come up through the grates cause the steam pressure to fall.

When the fire gets holes in it or a heavy bed of coke is formed, when using a coking coal, the two-pronged hook should be used to level the top of the fire, filling up the holes and breaking up the coked coal. This does not mean, however, digging down into the fire clear to the grates, mixing together the green coal, ashes and clinkers as a great many firemen do, but merely leveling off the top of the fire and not disturbing the bed any more than is absolutely necessary. After getting the fire level, then scatter the coal across the fire, beginning at the back and working to the door, or else scatter each shovelful in a long strip from back to front, with sometimes an extra shovelful, if needed, across the grate just in front of the deadplate.

*The Alternating System:* The best one for universal use and that used by the U. S. Geological Survey at its testing plants under hand-fired boilers. In this system fire the fresh coal in alternate doors, so as to cover half of the grates at each firing, allowing equal intervals of time between each firing. Where the furnace has three doors, as is the case with the larger types of boiler, the usual plan is to put fresh coal on the front half of grates in doors Nos. 1 and 3 and on the rear half in door No. 2; then fire on the rear half through doors Nos. 1 and 3 and in front through No. 2, etc., so as to keep one-half the grate surface at all times free from green coal.

Strip firing, as described under the spreading system, is probably the best way to place the coal, but it must be done regularly and with care. The important point about the alternate firing is to know just when to put on coal and how long the charge on each side will last without burning down too much and allowing an excess of air to come up through the fire.

This system requires more care and skill than the spreading system, but it is undoubtedly the best. At plants where two or more firemen are required this system must be used with regularity, so that two doors will never be fired at the same time, or at least never two doors whose furnaces lead to the same stack. Where two firemen are used, an excellent plan is to have one man do all the firing for, say, half an hour, while the other one rests.

The best firing on stationary boilers that the writer has ever seen was done in this way by two firemen at a plant in the Michigan copper country, equipped with four Stirling boilers. One man started at the end and went down the line of boilers, firing alternately doors down and back, two or three shovels to a door, never stopping until his half hour was up. The other fireman was at liberty during this time to do anything he pleased. Both of these men were very skilful and did not use the hook or slice bar more than two or three times a day, although they were using a coking coal, and the steam pressure never varied over five pounds, although the boilers were worked over their rating.

Where there are a number of boilers, a time system of firing similar to that used on some of the ships in the navy could be adopted, having a number over every door and a red light, or a number and a gong, the first to be illuminated and the latter rung when time to fire, the whole worked by hand or by a motor. A similar plan is used, or was used, at the model plant of the Wood Worsted Company, where each door has a red lamp above it, lighted automatically at regular intervals, when that door is ready to be fired.

### Careless Firing

The three methods all have their good points; each one may be used to the best advantage under certain conditions and any of them will give good results with care, attention and skill. Now a few words as to methods commonly used that are wasteful of fuel and show either ignorance or carelessness on the part of the fireman.

First—Firing at long intervals and then putting on so much coal as to deaden the fire and reduce the draft, and after two or three firings taking the slice bar and breaking up the fire, turning it upside down and making holes and high places. This method is seen at its best (or worst) among the Southern cotton mills with negro firemen.

Second—Putting all or most of the coal in the middle of the grates, so that the fire has the shape of a haystack, allowing cold air to come up all around the edges, and keeping down the temperature of the furnace.

Third—Throwing all the coal on the front half of the grates, piling up the fire there so that little or no coal reaches the back of the grates and the fireman cannot tell anything about the conditions there. This way is very hard on grates and usually means a lot of coal on the deadplate and cracked or warped fronts.

Fourth—Trying to keep a level fire, but allowing too long a time to elapse between firings, so that the coal burns out in spots, steam goes down, and fire must be leveled and built up again.

### Leveling and Slicing Fires

When the fire begins to burn in holes or a mass of coke is formed at any point, then the fire should be leveled on top, so as to fill up holes or break up the coke. For this purpose, either a scraper or a two-pronged hook should be used, but care should be taken not to dig down to the grates and mix up green coal or coke with the ashes and clinkers that may already be formed on the grates. Another tool for leveling only is used sometimes and is really the best, viz., a piece of ½-inch pipe long enough to reach to the bridgewall, with a ½-inch tee screwed on one end to which is screwed at each end a piece of ½-inch pipe about 12 to 14 inches long. By running this tool over the top of the fire it can be leveled without digging down into the fuel and making holes, as is often done when using the hook.

Slicing is usually done for one or both of two purposes: First, to break up clinkers and clear grates of ashes or to break up the bed of coal so as to give a better supply of air through the fire. When the slice bar is used, it should be slid along the grates at three or four different points and raised only enough to loosen up the bed of coal, except when cleaning fires. It should not be raised clear up through the fire, as that will make holes in the fire and allow green coal to go through to the grates. The good fireman will do as little leveling and slicing as possible, because he has learned from experience that it not only makes his work harder, but that he will waste coal through the grates and will increase the tendency of the coal to clinker.

### Frequency of Firing

The old rule, "Fire a little at a time and often," should be altered to read as follows: Put on coal as often and in such quantity as the fire may need, but keep the fire in such condition that a moderate amount of coal put on at regular intervals will last the longest possible time. It is obvious that no rules can be given which will fit all cases. The frequency of firing and the amount of coal to be put on at a time depend upon the size of the grates, the conditions under which the boiler is worked, the rate of combustion, the kind of coal and the skill of the fireman. The following general instructions, however, may be followed:

Do not put on large amounts of coal at long intervals, covering the fire with a thick bed of green coal, but only as much as is absolutely needed.

Do not put on so little at a time that the grates are not properly covered and the fire burns in holes.

Fire with some regularity and according to the demands for steam.

Do not fire so little at a time that the furnace doors are kept open continually.

See that each shovelful of coal counts, that is, goes to the right place; and don't fire aimlessly, but put the coal where it is needed and nowhere else.

Don't put one shovelful of coal right on top of the previous one.

Don't put on a full shovelful of coal when part of one would be sufficient. It is better, in fact, never to put on a full shovel of coal at any time, as the chances are that too much coal will be put in

one place. The large-size scoops should never be allowed in the boiler room, and a good fireman does not want them.

### Cleaning Fires

There are several different ways of cleaning fires, any one of which will answer if the work is done thoroughly. Probably the most frequently used and the best way is to clean first one side of the grates and then the other. This is done by building up a heavy fire on one side and allowing the fire on the other to burn out, then pulling out all the dead ashes and clinkers, and pushing or leveling the good fire from the other side on the bare grates and allowing that side to burn down. At the same time a good fire must be quickly built on the first side cleaned, so as to have enough fire to level over on the second side cleaned.

Another method, also much used, is to clean first the front half of the grates and then the back. To do this, build a heavier fire at the back and allow the fire to burn out in front; when this has burned out sufficiently, push back all the good fire, then break up clinkers in front and pull them out. Next, pull the good fire to the front and cover it over with coal; then loosen up the clinkers and ashes at the back and pull or jump the clinkers over the bank of live fire and out of the door and rake the ashes through the bars. After this is done spread the fire evenly all over the grates.

Whatever method of cleaning fires is used, clean the fires thoroughly, especially next the bridgewall, leave as much live fire on the grates as possible, but remember that every piece of clinker left on the grates means more trouble at the next cleaning.

### Kindling, Starting and Banking Fires

A very good way to start fires, and one that is much used, is to cover the grates with lumpy coals, leaving a small space clear just in front of the door. In this space start a fire of kindling and oily waste and as this fire gets hotter, it will gradually ignite the coal. This is a better way than trying to build a fire in the middle or all over the grates, as it will to some extent concentrate the draft and air supply on the cleared place where the fire is started. Unless there is some special reason for not doing so, steam should be raised slowly as there will be less strain on the boiler. With water-tube boilers this is not so important, however.

If the fire has been banked, all of the ashes and clinkers should be cleaned off or shaken through the grates. After this has been done, spread the bank of live coal evenly over the grates and put on the necessary amount of fresh coal, the lumpier the better. The damper and ash-pit doors should be open until the fire has been put in proper shape for starting up.

The usual method of banking fires is to push the good coal left after the plant is shut down against the bridgewall and cover it over well with fresh coal, preferably wet slack, as this will usually form a crust around the live fire and retain the heat better. It is better to bank the fire at the bridgewall than in front, as the ashes and clinkers remaining on the grates will keep out the cool air. After banking, the dampers should be almost closed and the fire doors and ashpit doors tightly closed.

### Steam Pressure and Feed Water

The fireman should try to keep the steam pressure as even as possible and not let it vary through any inattention, carelessness or laziness on his part. When the steam pressure varies either way, with a steady load on the boilers, the condition of the fire is such as to cause the variation, and the fireman should always endeavor to find out what caused the change. To do this he must watch the fire closely every time the door is opened and know its exact condition.

Variations in steam pressure are not only hard on the boiler, owing to the unequal expansion and contraction, but are the cause of waste of fuel, if the pressure goes down, as it will invariably take more fuel and labor to get the steam up to the required pressure than it would have taken to have kept the steam up. Then it is always more difficult to keep the water steady and the feed regular if the steam is allowed to go up and down.

The fireman should never allow the boilers to blow off, as that is a waste of coal, water and of his own labor. If steam goes to the blowing-off point, the damper should be closed, not the ashpit doors. The furnace doors or boiler-front doors should never be opened for this cause. The use of automatic damper regulators will attend to this matter and they should be used wherever possible.

The boiler-feed pump or injector and feed valves should be so regulated as to keep the water in the boiler at the same level, and its hight should not be allowed to vary any more than absolutely necessary. This will require attention, but will save fuel and labor and wear on pump and boiler.

### Wetting Coal

The practice of wetting coal before using it under boilers is so widespread that it would seem there must be some good practical reasons for it, although theoretically it causes a loss in heating power. The writer believes that in the majority of cases the wetting of coal is an advantage, especially the semibituminous coals and the highly volatile coals, and that the practical reasons for wetting coal will generally outweigh the theoretical or chemical reasons for not wetting it.

### Smoke

The appearance of smoke is a sure indication of imperfect and therefore wasteful combustion. The color of smoke is due to the small particles of carbon carried out of the stack before they are burned, but the loss of heat due to their not being burned in the furnace will not average more than 2 per cent. of the total heat value of the coal. Smoke, however, is a sign of bad conditions in the furnace and means that some amount of the heat from the gases of the fuel is being wasted, in addition to the loss from the carbon particles and this additional loss may amount to 15 or 20 per cent. of the total heat value of the fuel.

This loss of heat in the smoke may be caused by either bad firing or badly designed furnaces or both, the coal being burned with either too much or too little air supply. Or else the air supplied has not sufficient time to mix with the gases and carbon to burn them.

Too heavy firing will make smoke; too light firing will have the same effect; stirring the fires will make more smoke; poor draft and forcing boilers are responsible for its production at many plants; uneven firing without regularity and uniformity will have the same effect.

Some coals will always make more smoke than others; the coals containing the greatest amounts of volatile or gaseous matter will make the most, under similar conditions, and it is impossible to fire the highly volatile coals without smoke unless with furnaces specially designed to burn them. It is possible, however, to burn the "smokiest" coals without smoke, if they are burned in properly designed furnaces and carefully and intelligently fired.

There is one thing that the fireman should know, and that is that a smokeless chimney does not always mean that there is no heat being wasted in the furnace. The fire may be too light and burned full of holes with cool air rushing into the furnace — conditions which would mean imperfect combustion—and yet no smoke will be made.

The fireman who wants to learn and to make his services more valuable will try to find out by experiment and asking questions and by reading, if possible, what constitutes smoke and especially why it is made at his own plant, and will then see what he can do to prevent its formation. Smoke can be burned after it has been formed, but not in the ordinary furnace, and the fireman's business is to prevent its being made.

Only general instructions can be given on this subject and they are the general rules of good, careful firing, as given elsewhere in this article, and summarized as follows:

Fire evenly and regularly.

Fire moderate amounts of coal at a time, and place coal where needed.

Keep the fire clean and bright all over.

Break up lumps and have the coal uniform in size.

Regulate the draft and air supply to suit the fire.

Keep the fire level, and don't allow it to burn in holes.

Watch the condition of the fire and the steam gage together.

Keep steam pressure even.

Keep the water at a regular hight.

Don't level or stir fires unless absolutely necessary.

After finding out the proper thickness of fire, keep it at that thickness and don't allow it to burn down lower.

Keep the flues clean.

Don't allow ashes and clinkers to accumulate on bridgewall or in combustion chamber.

Don't allow too long intervals between firings.

## Catechism of Electricity

857. *Is there any other type of alternating-current motor besides a synchronous motor?*

Yes; the principal other type is the induction motor.

858. *What are the distinguishing features of the induction motor?*

An induction motor differs from a synchronous motor in the construction of its field magnet or stator, in not requiring separate field excitation and in having its armature current induced in the conductors instead of being supplied directly from an external circuit.

859. *What are the features of construction of an induction motor?*

The induction motor consists principally of two parts, one stationary, the other movable. The former is usually the primary or "field" member, composed of a laminated iron core carrying a winding very similar to that on the armature of an alternating-current generator. The moving part is the secondary or armature member, consisting of a laminated iron core carrying heavy conductors which lie in longitudinal slots and are connected together at the ends with copper rings securely riveted and soldered in place. The primary circuit is supplied with alternating current, and this induces currents in the armature conductors, which currents react on the magnetic field set up by the primary winding and thereby cause rotation of the armature.

860. *Illustrate the principle of operation of the induction motor by means of a diagram.*

Referring to Fig. 274, which shows a 12-pole field magnet wound so as to produce three sets of four poles each, it will be evident that if each set of coils, *m, n* and *s*, be supplied from one phase of a three-phase circuit, the poles *m m m m* of the polarities shown resulting from one phase, would be immediately followed in point of time by the poles *n n n n* of the same respective polarities resulting from the next phase, and these by the poles *s s s s* from the third phase. There would result, therefore, a rotation of the axis of the magnetic field, producing what is commonly termed a rotary field.

The armature *a*, sometimes called the rotor, consists of a large number of uninsulated copper bars *r*, running lengthwise through the periphery of the armature core and electrically connected to each other at each end by a copper ring *c*. The currents induced in these armature conductors by any one set of poles bear such relation to the poles produced by the next phase as to produce an effective torque, and the armature *a* will consequently start from rest with considerable torque and quickly speed up until the dragging effect or pull is only slightly greater than the counter pull exerted by the motor load.

861. *If the field winding be supplied with single-phase current, will the armature rotate?*

Not unless it is started up by some outside force; this is due to the fact that a

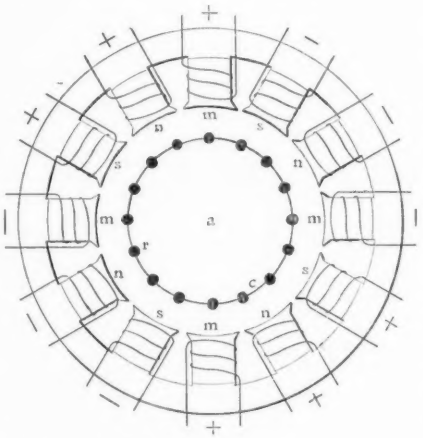


FIG. 274. DIAGRAM ILLUSTRATING THE PRINCIPLES OF OPERATION OF THE INDUCTION MOTOR

single-phase current will not produce a rotary field while the armature is at rest. After it is brought up to normal speed, the magnetic field set up by the armature conductors reacts on the magnetic field of the stator to produce a rotary resultant field.

862. *Has the type of armature shown in Fig. 274 any special name?*

It is called a "squirrel-cage" rotor on account of its mechanical construction.

863. *Can induction motors be operated with any other kind of armature?*

Yes; there is another kind which is wound somewhat like the field or stator coils, but with insulated copper conductors of relatively large size. If the motor has to start with a heavy load, as in the case of elevator and hoist motors, this type of winding is preferable. By carrying the terminals out to slip rings and using brushes on them, an external non-inductive starting resistance can be used.

864. *What is the object of using such a resistance?*

It gives the motor a high torque with a comparatively small starting current, making it possible to start the motor at full load running torque with an armature current not much in excess of that required at full speed. This is done by advancing the phase of the armature current so that it is in a better instantaneous position with respect to the stator poles.

865. *Cannot motors with squirrel-cage armatures be made to start with considerable torque?*

They can, but they require much greater starting current than those of the other kind.

866. *How may the speed of the rotating field be calculated?*

The speed of the rotating field in revolutions per second is equal to the frequency of the supply current in cycles per second, divided by one-half the number of magnetic poles produced by each phase of the supply current. Thus, in a three phase four-pole motor, there would be four magnetic-field "poles" produced by the current in each phase, and if the supply current had a frequency of 60 cycles per second, the speed of the rotating field would be $60 \div 2 = 30$ revolutions per second. The speed of the armature is more or less below the speed of the rotating field.

867. *Can the speed of the armature ever become equal to that of the rotating field?*

No; in order that the electromotive force induced in the armature conductors may be sufficient for the resulting current to produce the required torque for rotation, the armature must always run below synchronous speed; that is, the speed of the armature must be less than that of the rotating field. The difference between these two speeds, expressed as a percentage of the speed of the rotating field, is called the "slip" of the motor.

868. *What determines the amount of slip in an induction motor?*

The load. As the load on the motor increases the slip increases, and as the load on the motor diminishes so also does the slip. It is evident, however, that the value of the slip can never become zero on account of the friction of the bearings, etc., but at no load it is so small that the speed of the armature is usually taken as equal to that of the rotating field. At full load the slip is such that the armature speed is from 2 to 10 per cent. less than the speed of the rotating field, according to the size of the motor.

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The Dominion liner "Laurentic," which was recently launched at Belfast, is triple-screwed, each of the wing propellers being driven by a four-cylinder triple-expansion engine and the center propeller by a turbine. The "Laurentic" is 565 feet long, 67 feet 4 inches beam and has a gross tonnage of 14,50. She will be used in the Canada trade.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

## WE PAY FOR USEFUL IDEAS

### Curtis Turbines and Oil in Boilers

I read the remarks in R. O. Richards' letter in the September 22 number, bearing on Curtis turbines and oil in the boilers. I would like to say a word on this subject. The old-style of machines were made to operate on a water step, and the water could overflow into the exhaust chamber, also acting as a lubricant for the step bearing. When it was deemed advisable to use oil for a step pressure, packing of carbon was provided, consisting of three rings, which formed a seal and also prevented an overflow of oil into the exhaust chamber.

The amount of steam used in this seal is optional with the engineer, but I find that about 7 pounds furnishes a good seal. The engineer may always help his vacuum by adding a little more steam, or by choking his three-way cock. The steam line to this seal, and the other seal, should be brought from the pressure side of the throttle valve; then, if the machine should trip the emergency and close the throttle valve, the vacuum will not be impaired.

These carbon packing rings are made in four sections, and consist of three rings, two of which are in one compartment, the pressure of steam being between the two lower rings, sealing one up and one down. The clearance between the rings and the shaft is 0.006 inch. The expansion of the shaft seals itself, and the other ring seals itself from the leakage of the two rings.

This clearance of 0.006 inch is the standard for seals and bearings, and when there is a greater clearance in the bearings a vibration of the machine is noticeable when running, but in the new styles there is a subbase which holds the step and step bearing so that there is no chance whatever of oil getting into the exhaust chamber, and the packing is between this subbase and the exhaust chamber.

WILLIAM BUTLER, JR.

East Somerville, Mass.

### Duplex Pump Trouble

A few days ago the writer was called to a power plant to straighten out a difficulty with a 6x4x6-inch duplex steam pump. The pump receiver was connected to the returns from the various ovens, coils, heating pipes, etc., any loss through leakage and waste being made good from the cold-water supply. As the temperature of the returns was in the neighborhood of 180 degrees Fahrenheit, this water was used for immediate boiler feeding.

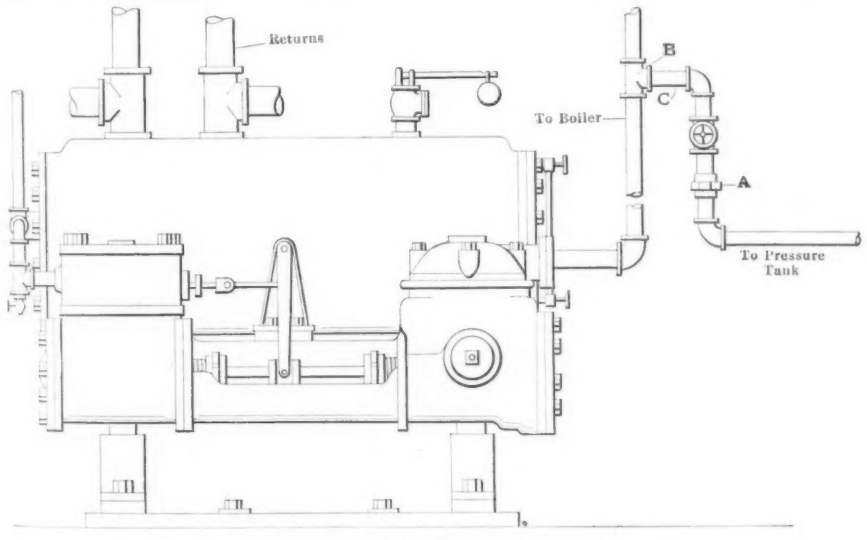



FIG. 1. SHOWING PIPING CONNECTIONS

The difficulty proved to be that the feed pump would not supply the boiler, although it was of ample capacity to do so. The engineer was a new man, his predecessor having been discharged. The fact that the operation of the plant had been satisfactory until the discharge of the old engineer led me to suspect a "nigger in the woodpile."

The piping layout was somewhat as shown in Fig. 1, all discharge water piping being 2 inches in diameter. Besides supplying the boiler, the pump was also arranged to feed a pressure tank at 125 pounds, through the connection shown. This tank was not working satisfactorily on account of a deficient water supply.

The pump was thoroughly examined and found to be in good condition, yet it failed to do its work. This indicated that

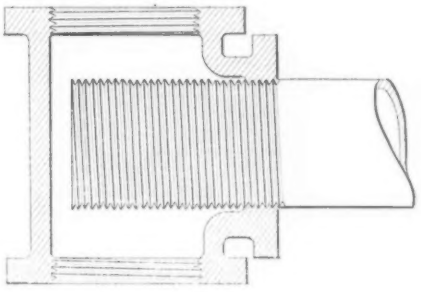


FIG. 2

the fault was not with the pump, but outside it.

The union at *A* was disconnected and the pump started at full speed. Instead of the abundant stream which should have issued, a tiny, tired trickle was all that appeared. The remaining nipples were taken out up to the tee *B*, where the trouble was found. Someone had cut the nipple *C* with a thread of such length that it screwed in and nearly filled the passage of the tee *B*, as shown in Fig. 2, thus cutting off the supply from the tank and boiler. When the pump was started, it ran with great rapidity, refused to deliver water to the boiler and pounded on the cylinder heads in a manner that threatened to knock them out, behaving, in fact, as if it were running entirely without water in the cylinder.

Such behavior could mean only one thing, considering that the pump would discharge against atmosphere but not against boiler pressure, namely, that there was a bypass, through which the water could surge back and forth, rather than discharge against the pressure. The only likely place for such a passage was between the suction- and discharge-valve decks. The water end was again dismantled in search of a crack in the casting which would furnish a channel for such an internal surge. The crack was not found, but four ½-inch holes, drilled to connect each suction valve well with

the discharge outlet, as shown in Fig. 3, so that the water, seeking the path of least resistance would squirt back into the suction deck from the discharge outlet, instead of going to the boiler or pressure tank.

The holes were tapped out and slotted,

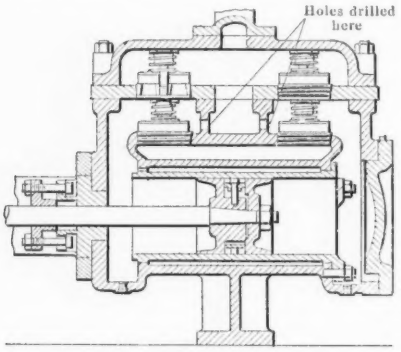



FIG. 3

headless screws screwed in flush on both ends. When the pump was again started, the pound had disappeared.

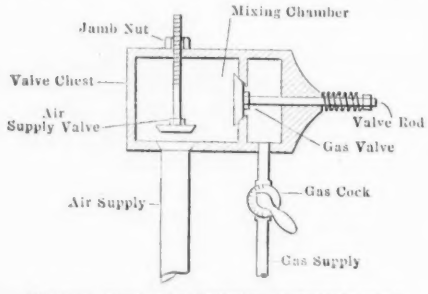
T. D. HAYES.

Cambridge, Mass.

## A "Runaway" Gas Engine

The other day a friend who owns a gas engine of the four-stroke type, governed by the hit-and-miss system, asked me to look at it and see what caused it to run away, although the governors seemed to be in good order. I found the trouble, which can be easily understood by referring to the accompanying sketch.

The air valve had been screwed down until the air supply was so choked that the suction in the mixing chamber became strong enough to draw the gas valve open at each cycle, regardless as to whether the valve rod came back or not. Thus, instead of taking gas only when the governors shoved the valve rod back, it




WHERE THE GAS-ENGINE TROUBLE WAS LOCATED

took gas on every suction stroke and speeded up until the mixture became so poor that it would not fire.

By throttling the gas at the gas cock he was able to hold the engine in bounds, but the running was not satisfactory. Raising the air-supply valve 1½ inches put the engine in good working order again.

My experience has taught me that the spark plug is almost the "whole engine," and considerable trouble may be saved by keeping it clean and the movable electrode well oiled. I use a good grade of gas-engine cylinder oil for this purpose, and with a small oil can oil the movable electrode four or five times in ten hours.

R. MANLY ORR.

Brantford, Ont.

## The Personal Element in Steam Plant Accidents

An engineer friend and I were discussing steam-plant accidents and who was responsible for them. He contended that they were all accidents, pure and simple, that could not be avoided by the engineer in charge and he should not be held responsible. I contended that in a large majority of cases the engineer was directly or indirectly responsible and that many accidents could have been avoided had proper foresight and care been exercised.

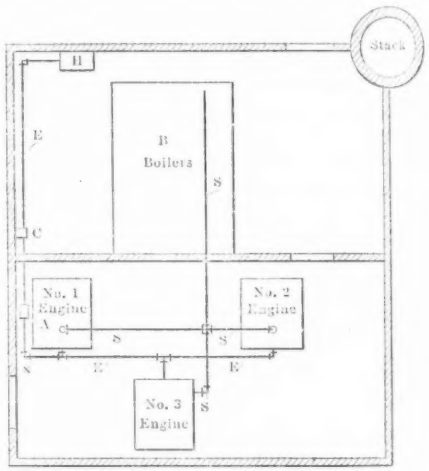
My friend took as an example to support his argument a recent flywheel wreck which resulted in considerable property damage and the loss of two lives. He claimed that a short-circuit was the cause and that the heavy load thrown on the jack-shaft pulley caused it to collapse, permitting the heavy main belt to jam in the flywheel pit, stopping the wheel so suddenly that it went to pieces. As the engineer was killed, the real cause was never known.

Now, I happened to know something of the way things were run in that power house, and in my opinion the wreck was the direct result of recklessness on the part of the men in charge.

The plant consisted of three cross-compound condensing Corliss engines, equipped with the usual safety-stop on the governor. It had been the practice in this power house to run with the safety stop *in* when heavily loaded, and it was probably in at the time of the accident. Probably a heavy load came on, caused, perhaps, by a short-circuit, and the engine slowed down; then the circuit-breaker went out, relieving the engine of practically all its load and it immediately speeded up, and before the governor could take hold and regulate the engine the wheel went to pieces. The engineer probably did all he could to prevent the accident, and gave up his life in the attempt, yet I contended that either he or his chief was responsible for running with the safety stop in.

Three years ago, in a plant near where I was working, an engineer wrecked three engines inside of 15 minutes. The plant consisted of three tandem-compound high-speed direct-connected units of 250 horsepower each and supplied lights and power to a group of buildings in a large city. It was in operation from 6:30 a.m. to 6:00 p.m., six days a week. Two engines were always in operation, one being held in reserve. On the morning in question the assistant engineer started up Nos. 1 and 2, as usual, by using a ¾-inch bypass around the throttle on the high-pressure cylinder. This would bring the engine up to speed before they were "put on the board." No. 2 had got up to speed and the engineer went to No. 1 to open the throttle wide, when he heard a crash at No. 2. He rushed over and shut off the steam, and as he did so heard No. 1 go the same way. He shut off No. 1 and rushed to No. 3 and got it going as soon as possible. No. 3 had barely got to full speed before it followed the example of the others and wrecked itself.

The frames of all three engines were broken in almost the same place, just ahead of where the low-pressure cylinder was bolted to the bed. The high-pressure-cylinder head of No. 1 was cracked, the shaft sprung and the strap on the cross-




LAY-OUT OF PLANT

head end of the connecting rod opened up about one-half inch.

The lay-out of the plant is shown in the illustration, where *S* is the main steam line from the boilers, which dropped about 15 feet to the engines, with no separator on the line; *E* is the exhaust line, which crossed the room back of the engines under the floor, a valve being placed between each engine and main exhaust line; *X* shows where the line came up through the floor for a distance of 16 feet, then ran back as shown; in the ell at *X* under the floor, was a 1-inch drip which was supposed to be open, and was found so shortly after the wreck; *A* is an oil separator; *C* is a deflecting tee, from which the line ran to the heating system, and to the exhaust head on the roof; *H* is an open heater, in which is a float valve connected to a 2½-inch pipe from the city water mains, which are under a pressure of 50 or 60 pounds; in addition to this connection there was another, 3 inches in diameter, controlled by an ordinary globe valve, the overflow from the heater was

2½ inches; *B* represents the boilers, six in number, of the return-tubular type, 72 inches in diameter by 18 feet in length.

One cause of this wreck was that the engineer did not take proper precaution to see if everything was all right in the first place, and, getting "rattled," did not investigate before he attempted to start No. 3 engine.

Here is another interesting item: The *Boston Globe* contained an account of a recent N. A. S. E. meeting and the reporter stated that "it was stated that the cost of producing 1000 pounds of steam varied from $15 to $30."

Power cost is high in Boston. According to the report, the cost per day of 10 hours for a 150-horsepower engine, using 30 pounds of steam per horsepower-hour at $15 per 1000 pounds of steam, would be.

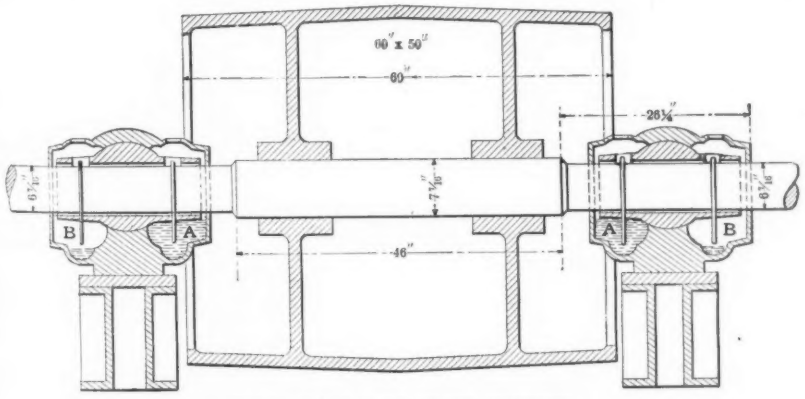
$$150 \times 30 \times 10 \times 15 = \$675{,}000.$$

W. E. SARGENT.

Franklin, Mass.

## Curing Troublesome Ring Oiling Bearings

A couple of ring-oiling bearings, placed on either side of a driving pulley as shown in the illustration, caused trouble. This wheel carried a heavy, three-ply leather belt, 4 feet wide and about 60 feet long, which was used for driving a large generator. The bearings had given the best of service for a while, when first one and then the other began to lose the oil through the outside ends. It was found that the oil was gradually being drawn to the inner ends *A* from ends *B*, and when full to overflowing it found its way into the pulley.




TROUBLESOME RING OILING BEARINGS

The bearings were in excellent condition, the construction very rigid and the most careful examination with line and level failed to show any want of alinement. The construction of the bearings was practically as shown, the inner-bearing shell being free to move on its support and adjust itself to any springing of the shaft which might have been caused by the strain of the belt.

The trouble was soon remedied by connecting the oil compartments with a ½-inch bypass.

H. M. WINSLOW.

Cumberland Mills, Me.

## A Flange Joint Clamp

A number of years ago I had charge of a plant consisting of several small units for the street-railway service and one large unit for lighting purposes. The original plant was for street-railway service and the lighting plant was put in as a side issue. The engines were installed in a row at the extreme end of the line from the boiler plant. Steam was supplied by one pipe line from the boilers, steam extending to the lighting engine at the extreme end of the line.

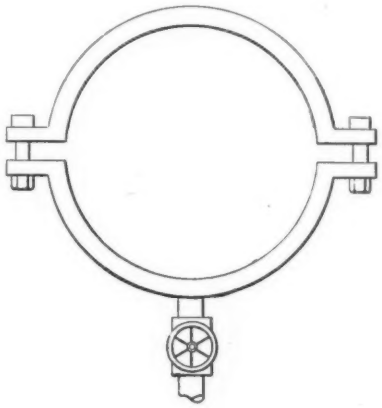


FIG. 1

On one occasion a flange joint about midway on the main steam line developed a leak at the gasket. At first we tried to stop the leak by wedging, but found it impossible to do so. We then made two half-round clamps to fit the outside of the flange, and put a strip of packing between it and the flange and attempted to screw it down tight enough to hold, but as soon as it commenced to tighten up the packing would blow out. We then hit upon the following scheme, illustrated herewith: A flange-joint clamp of ⅝-inch strap iron, wide enough to cover the edges of the flange, was made to fit the outside of the flange union. In the center of one-half of the clamp a hole was drilled and a ½-inch nipple screwed in, and on the end of this was placed a ½-inch valve. This is shown in Fig. 1. Fig. 2 is a view of the half clamp showing where the hole for the valve was drilled.

Fig. 3 is a piece of ⅛-inch sheet packing cut long enough to fill the half clamp containing the valve, with a ½-inch hole cut in the center opposite the hole in the clamp. There was also a narrow groove cut in the packing extending both ways from the hole in the center. The grooves were long enough to cover the points in the flange coupling where the gasket had blown out. The grooves were not cut entirely through the packing, but were hollowed out, with a thin portion of the packing left on the back of the gasket.

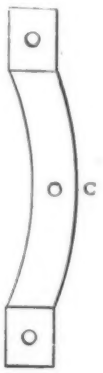



FIG. 2

FIG. 3

The idea was to conduct the escaping steam to the ½-inch opening without putting much pressure on the packing. There was also a piece of packing cut for the other half of the clamp as a precautionary measure should this part of the gasket give out. The packing containing the hole was placed on the half clamp with the hole *D* in the packing directly over the hole *C* in the clamp to which the valve was attached. This half of the clamp was then placed directly over the leak in the flange gasket, with the valve left open. The other half of the clamp was then put on and both halves screwed tightly together by means of bolts through the lugs on the clamps. The steam from the leaking flange was allowed to escape through the ½-inch valve. The packing was allowed time to vulcanize and after tightening the bolts again the ½-inch valve was closed. The joint was perfectly tight and remained so until such time as the new line we were putting up was finished, when we were able to shut the steam off and put in a new gasket.

A. CHISHOLM.

St. Louis, Mo.

## How to Clamp Hose, Reface Pump Valve and Make Ash Hoe

When a steam hose has been stretched until the inside diameter is too large for a new coupling, it can be reduced at the end to its original size by using a clamp made as shown in Fig. 1. This consists of four pieces of hoop iron, drawn together gradually with four bolts, while the hose is kept hot and soft with steam.

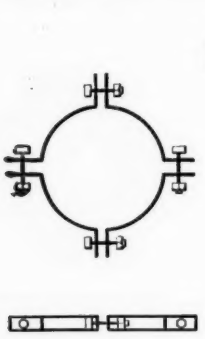


FIG. 1

The worn portion of a rubber pump valve can be removed by taking two suitable boards, and with an expansion bit, bore a hole in one board the exact diameter of the valve, and ⅛ inch deep. The hole opposite, in the other board, should be of sufficient depth to bring the boards nearly together when the valve is placed between them. A piece of cardboard is put between the portion in the vise, to provide clearance for the saw. The valve can be finished by rubbing on sandpaper placed on a flat surface. Fig. 2 shows the idea.

A method of making a fire hoe which experience has proved to be strong and durable, is shown in Fig. 3. A fork is made of ⅝-inch round iron. Holes are drilled in the blade and nuts are put on each side of it. The fork is welded into a suitable length of ½-inch steam pipe.

CHARLES HAEUSSER.

Albany, N. Y.

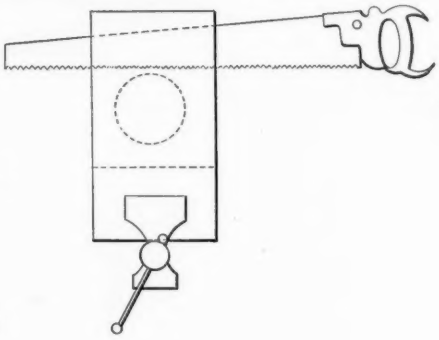


FIG. 2

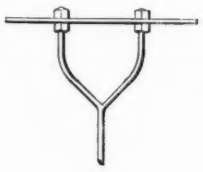


FIG. 3

## Exhaust Steam Heating

Take a high-pressure engine exhausting into a heating system, say at 2 pounds pressure. The back pressure will have a total in heat units above 32 degrees of 1148.9 B.t.u. The average temperature of the feed water without a heater would be 55 degrees. Therefore, we have

$$1148.9 - (55 - 32) = 1125.9$$

B.t.u. as the net saving for each pound of steam thus saved. If the heating system requires 4000 pounds of steam per hour to maintain the required temperature in the building, and the coal used evaporates 9 pounds of water per pound of coal, at the above temperature of 55 degrees

$$4000 \div 9 = 444.4$$

pounds of coal would be saved each hour. While the above may not be the exact figures, it will illustrate the saving in utilizing the exhaust steam instead of permitting it to escape to the atmosphere and turning live steam into the heating system.

There are other things to take into consideration, such as heat conditions, condensing plants, or badly arranged systems which run the back pressure up too high on the engine, and thus lose all that is gained. This can be overcome by the use of a vacuum-heating system which will do good work on 1 or 2 pounds back pressure.

In a certain machine shop the engines were replaced by motor drive, but it was necessary to keep steam in the boilers for heating, which consumed nearly as much coal, besides the cost of current consumed by the motors.

Exhaust steam passing through an engine gives up only about 20 per cent. of its heat units, therefore why not make use of the balance?

R. D. SPRAGUE.

Vancouver, B. C.

## Diagrams to Criticize

The accompanying diagrams were taken from a Westinghouse automatic compound engine, 18x30x16 inches, running at 220 revolutions per minute. The steam pressure was 145 pounds. They were taken with an 80 spring at different loads.

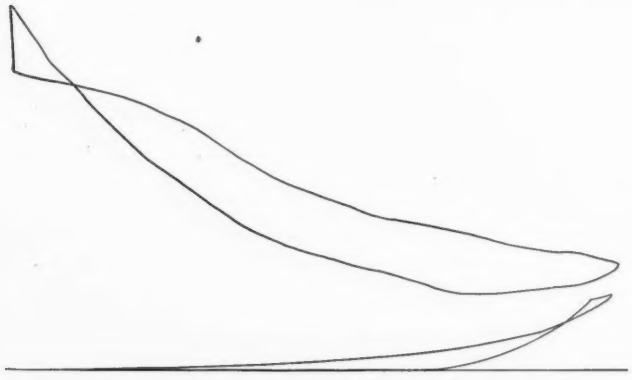


FIG. 1. NO LOAD

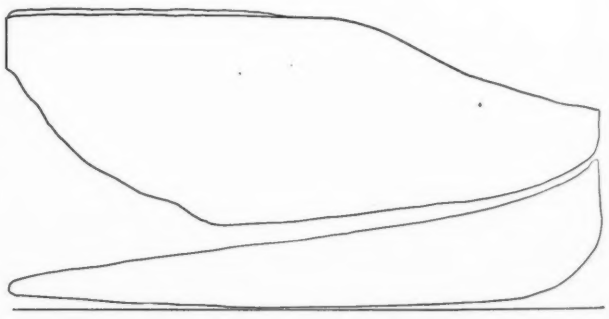


FIG. 2. AT 97 PER CENT. NORMAL LOAD

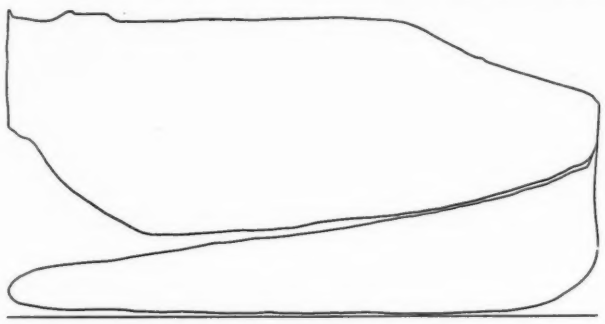


FIG. 3. THIRTY PER CENT. OVERLOAD

It would be of interest to hear from readers of POWER AND THE ENGINEER in regard to them.

C. E. NIGH.

Morgantown, W. Va.

## Belt versus Direct Drive

For many years engine builders have used a belt drive for their governors and have harped upon the fact that they all contain what is known as a "safety stop." This is a misnomer, as the contrivance is really a "convenience" device, to enable the engineer to shut down his engine and start it again without giving any attention to the governor.

In Fig. 1 is shown a light-duty governor, which will illustrate what I mean. The idler pulley resting on the governor belt holds in position two supports, upon which the governor-lever collar rests when the engine is slowing down and out of service. Should the belt break, however, when the engine is in service, the idler pulley will fall, and by means of rods and levers will withdraw the two supports mentioned and allow the governor collar to come down into what is known as a "safety" position, throwing into service the safety cams on the steam bonnets, which will prevent the admission of steam to the cylinder.

Should the belt slip, however, instead of break, excessive speed might easily be reached by the engine, and the safety device would in no way act as such.

It is evident that it is a safety device only in case the belt breaks; and the belt is much more apt to slip, as pointed out in the recent editorial on this subject, than it is to break.

In this connection, it would be well to point out that the specification for large engines drawn by a good many engineers calls for two governors, one to take care

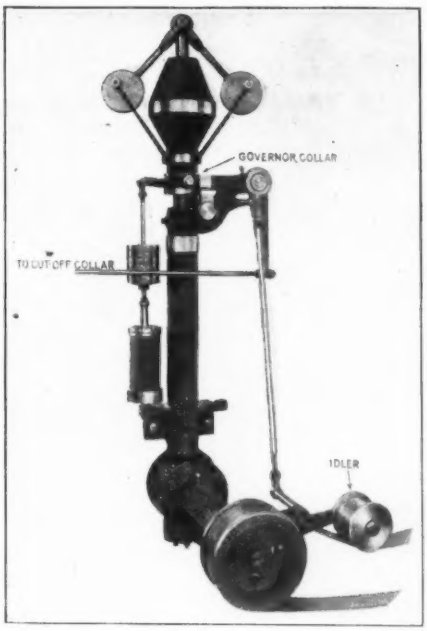



FIG. 1. A LIGHT-DUTY GOVERNOR

tomer will pay the slight additional cost.

Instead of using a belt and pulleys on the shaft and on the governor bonnet, two rope sheaves are used, one on the main shaft and the other on the governor bonnet. Each pulley is grooved for three

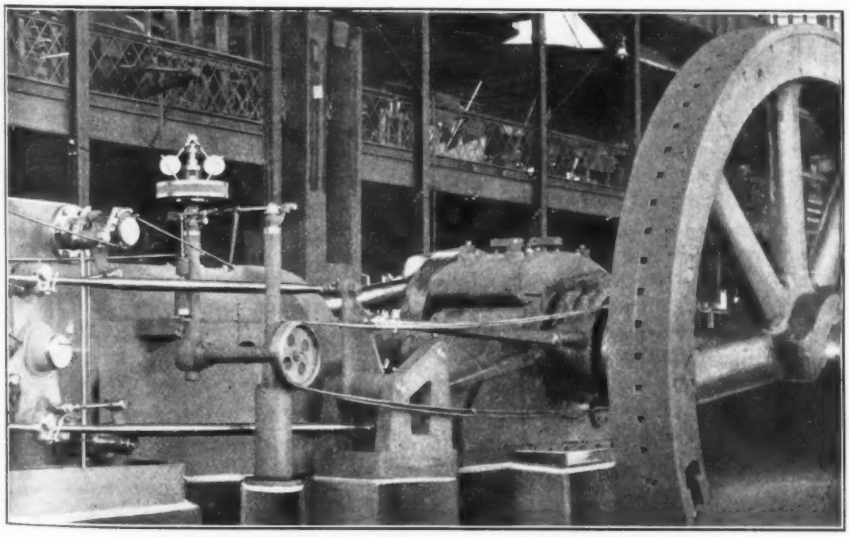


FIG. 2. WISCONSIN ENGINE COMPANY'S DRIVE

of regular service and the other to come into service in case the engine should exceed by a predetermined amount the standard speed controlled by the first governor.

Both governors are in continuous rotation, driven almost invariably by belts, and both, therefore, subject to the criticism made in the editorial. The fact that the auxiliary governor seldom comes into play, and gets little attention from the engineer, further decreases the chance of its becoming effective in case of necessity.

In Fig. 2 is shown a drive which the Wisconsin Engine Company always advocates and often furnishes where the customer will pay the slight additional cost.

Instead of using a belt and pulleys on the shaft and on the governor bonnet, two rope sheaves are used, one on the main shaft and the other on the governor bonnet. Each pulley is grooved for three ropes, any one of which is of sufficient size easily to drive the governor. The ropes have very little tendency to slip, no matter what their condition, because they work in V-shaped grooves; and should any two of them for any reason become ineffective, the third would still drive the governor.

A direct drive for a Corliss-engine governor has not been very successful and few builders use such a drive. The above-mentioned company has made a practice of using governors rotating at a speed of from 200 to 300 revolutions per minute, instead of from 60 to 80 (as in the old type), and with the rope drive very close regulation is possible.

CORNELIUS T. MYERS.

Corliss, Wis.

## How Gas Should Be Metered and Charged For

This subject has been discussed by different engineers for several months past, and it seems that the laws governing the pressure and volume of gases are not as generally known as they should be. I will try to explain in this article how to figure the pounds of gas from the pressure, volume and temperature, and also show the relation that exists between these three or, rather, four physical properties. The first law of gases is as follows:

*The volume of any gas is inversely proportional to the absolute pressure.*

The standard conditions for measuring the volume of a gas is at 760 millimeters of mercury, or 29.92 inches, which is equivalent to 14.68 pounds absolute. Suppose we have such a problem as the following:

What volume will 1 cubic foot of gas under 20 pounds absolute pressure occupy at 35 pounds absolute pressure? Applying the rule, we have

$$\frac{1 \times 20}{35} = 0.571 \text{ cubic foot.}$$

This is the method of calculating the volume of any gas at any pressure and is the same whether the pressure is stated in pounds or inches of mercury, millimeters of mercury, or inches of water. Of course, both the initial and final pressures must be stated in the same kind of terms. The thing to remember is that as the pressure increases the volume decreases, and no difficulty will be experienced in getting the statement correct. The second law of gases is:

*The volume of any gas is directly proportional to the absolute temperature.*

Since the Centigrade scale is not used by engineers, I will describe only the application of this law in terms of the Fahrenheit scale. Suppose we have the following problem:

What volume will 1 cubic foot of gas at 50 degrees Fahrenheit occupy if the temperature is raised to 100 degrees Fahrenheit? Applying the rule, we have

$$\frac{1 \times 459.2 + 100}{459.2 + 50} = 1.098 \text{ cubic feet.}$$

Since the absolute zero on the Fahrenheit scale is 459.2, this number must be added to the temperature of the gas. The

standard temperature for measuring gas is 32 degrees Fahrenheit or 491.2 degrees absolute.

These two laws may be combined in the same equation as, for example, in the following problem:

What volume will 1 cubic foot of gas measured at 15 pounds absolute pressure and 50 degrees Fahrenheit occupy at 35 pounds absolute pressure and 100 degrees Fahrenheit? Using the rule, we have

$$\frac{1 \times 15 \times 459.2 + 100}{35 \times 459.2 + 50} = 0.471 \text{ } \textit{cubic foot.}$$

If the pressure is taken from a gage or a mercury column, the barometer pressure must be added to make it absolute.

To obtain the pounds of gas in a given volume, reduce the volume to the standard conditions and then multiply the volume thus found by the weight of 1 cubic foot of the gas. Many reference books for engineers give a table of the weights of the most common gases. Natural gas is principally what is known as marsh gas or chemically as methane. At standard conditions it weighs 0.0448 pound per cubic foot.

In my opinion, gas can only be sold fairly either at a certain rate per 1000 feet, measured under standard conditions, or at a certain rate per 1000 B.t.u. Of course, it is impossible to measure gas under exact standard conditions, but the volume can easily be calculated if the conditions under which the measurement was made are known. The data necessary are as follows: Barometer pressure, pressure of the gas going through the meter and temperature of the gas going through the meter.

If some ingenious person were to get to work, it is very possible that some condensating device could be made that would make the meter read in cubic-foot standard. As far as I know, no such meter is on the market; therefore, the only thing for the gas consumer to do, if he wants to be sure that he is getting what he is paying for, is to invest in a recording barometer, a recording pressure gage, and a recording thermometer.

This may seem like an expensive layout, but it will probably pay for itself in a short time if much gas is used, or if the gas company estimates it without knowing the conditions. It must be kept in mind that the conditions vary every day. Thus, in the summer, one would get less gas (that is, heat units) than in the winter for the same money. The reason is that in the summer the gas is warmer and what was 1 cubic foot in the winter is more than 1 cubic foot in the summer, but it has not increased in heating value at all. Also on a day when the barometer is low one would get less gas for the same money than on a day when it was high.

The whole question may be summed up in the following statements: One pound of fuel gas *always* contains the same number of heat units regardless of its volume, but the number of cubic feet in one pound of gas *varies greatly* under different temperatures and pressures.

JAMES E. STEELY.

Covington, Ky.

## An Obscure Electric Circuit Trouble

For the past three weeks I have been having trouble with an alternating-current arc circuit which has 110 eighty-volt lamps taking a constant current of 7 amperes.

By referring to the diagram it will be seen how circuits Nos. 1 and 2 are connected. No. 2 circuit operates O. K., but No. 1 circuit gives trouble.

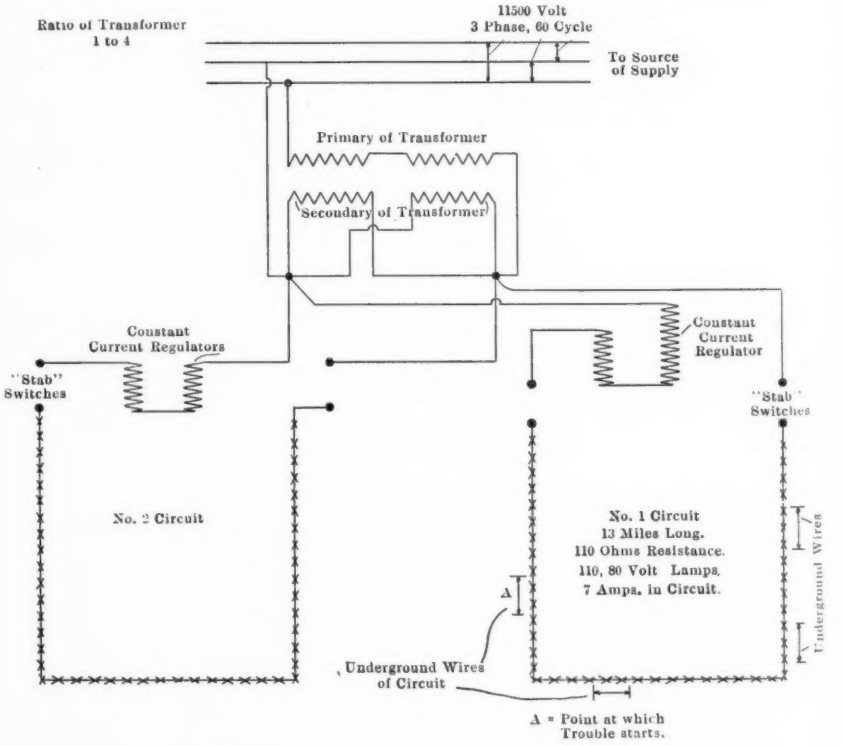
When starting No. 1 circuit we inserted the "stab" switch on the regulator side. Immediately there was a discharge through the lightning arrester to the ground, and at the same time the regulator acted as if the line wires were short-circuited. The ammeter on this side indicated 7 amperes, but only 40 of the 110 lamps were burning. Then we closed the other side of the circuit, but it had no effect on the regulator, and the ammeter on this same side showed 4 amperes. An insulation test was then made, which showed one megohm resistance.

The lights would all burn on the aërial wire to the first underground cable. At this point the current would gradually decrease and the last lamps that tried to burn would merely flicker; the rest of the lamps were not burning, although there were 4 amperes flowing through them.

On pulling out some of the lead cable we discovered that the lead was split and the rubber insulation spongy. There were small white spots on the inside of the lead cover and small holes on the inside of the rubber, which apparently showed that there was a distributed leak. Since from this point on no lamps were burning, it would indicate that there was a ground, either between the last lamp and transformer, or on the transmission line.

After grounding the circuit of a few lamps from this apparent distributed ground, all lights on the circuit burned O. K.; but the regulator still acted as before, and had to be shut down on account of its beginning to burn.

Did the ground we put on the circuit show that there is no ground between the last lamp and transformer or on the transmission line? Why does grounding the circuit cause all lamps to burn?


Ratio of Transformer 1 to 4
11500 Volt 3 Phase, 60 Cycle
To Source of Supply
Primary of Transformer
Secondary of Transformer
Constant Current Regulators
Constant Current Regulator
"Stab" Switches
"Stab" Switches
No. 2 Circuit
No. 1 Circuit 13 Miles Long. 110 Ohms Resistance. 110, 80 Volt Lamps. 7 Amps. in Circuit.
Underground Wires
Underground Wires of Circuit
Δ = Point at which Trouble starts.

SHOWING HOW THE CIRCUITS ARE CONNECTED

Referring to the diagram, Nos. 1 and 2 circuits are connected up the same. No. 2, which is O. K., has been transferred to the stab switches of No. 1, but the latter still operates as stated. This shows that the transformer and No. 1 regulator are O. K., and that the trouble is on the circuit, does it not? When the transformer is connected to a different source of supply the circuit operates all right. Why is this?

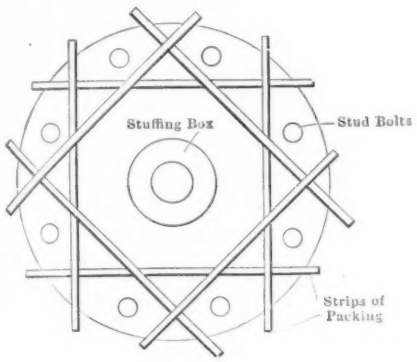
The transformer used is a single-phase, 60-cycle, 2000-volt primary, 8000-volt secondary, 112-kilowatt machine, and is connected when taking current from a different source of supply, as shown in the diagram.

J. P. MINTON.

Chicago, Ill.

## Replacing a Gasket

When the gasket between the steam cylinder and frame of our 6 and 12 by 12-inch horizontal straight-line rotative dry-vacuum pump blew out one day, we endeavored to stop the leak by driving in thin wooden wedges, but this proved to be but short-lived so it was necessary to resort to more permanent repair. The floor of the engine room was of concrete and




HOW STRIPS OF SHEET PACKING WERE USED IN CONNECTION WITH GASKET

steel construction, and the foundation of the pump was of concrete cast into the floor. The foundation bolts were held in the block by washers 6 inches square, and these were wholly imbedded in the concrete, except for the projection provided for bolting down the machine.

When we came to release the pump from its foundation bolts, with the idea of removing the steam cylinder from the frame, we discovered that it would be impossible to break the joint in the steam piping, as the designers committed the blunder of locating the union between the throttle and the boilers, and there was no other way to shut off the steam from the auxiliary steam main without depriving the other auxiliaries of their necessary supply. It was impossible to lift the frame from its foundation bolts, as the steam cylinder had stud bolts by which the two were bolted together.

There remained for us, then, but one thing to do. After removing the nuts from the foundation bolts, the eccentric rods, connecting rods on either side, and the nuts from the stud bolts, we drove the iron wedges between the cylinder and frame and forced the two apart as far as safety and the clearance of the foundation bolts would allow. Then with a hacksaw blade we carefully cleaned the faces of the two pieces as well as we could, after removing the old gasket. Next we cut eight pieces of sheet packing, ½ inch wide and long enough to allow the ends to project, as shown in the illustration. After these were properly placed, the wedges were removed and the nuts turned up to a snug tightness. Steam was next allowed slowly to enter the cylinder long enough to warm it up fairly well, and then the nuts were tightened as much as possible with safety, and the ends trimmed off neatly. This was done six months ago. The pump has been in operation every day since, and as yet no sign of a leak has appeared.

THOMAS J. WALSH.

Woonsocket, R. I.

## Operation of Steam Turbines

Operators of Curtis turbines should keep the strainers in the baffle clean and look at the baffle every time the machine is shut down. When the shreds and lint come a little thicker than usual, it is better to repack the step pumps and not wait until it is necessary to pack them. Keep the oil clean and permit a large amount to flow through the bearings, and bring the drain from the upper and middle bearings out separately and pipe them to flow into a funnel leading to the oil return. By feeling this oil one can tell, without climbing up on the machine, the condition of the bearings, and which one is heating. Another idea is to make a wire frame for holding a dairy thermometer and place it so that the oil will flow over the bulb to give the exact temperature. The screen in the steam pipe should also be kept clean.

By using an asbestos gasket 1/32 inch thick on the cover of this screen, with wire insertion, and red lead on one side and graphite on the other, the screen is more easily got at.

There is a choice of hight of wheels, or clearance, at the top and bottom. I prefer to have the machine run as high as possible, then if the step strikes it will have more to wear off before the blades strike. The closer the wheels run up against the nozzles the less leakage there is over the edges of the wheels. We had the first six nozzles under the governor and the first section of stationary blades on the 1000-kilowatt machine wear quite badly and they had to be changed after about 18 months' service. Some of the nozzles were cut one through to the other, and some of the stationary buckets were about half gone.

Vibration will probably cause the most bother. There are three different causes that produce vibration: machine being out of line, out of balance, and loose bearings. If the machine has just been set up, it is safe to say it is out of line. If it has been running long and the vibration grows slowly, the bearings are getting loose; or if the running element has had any work done on it, it may be out of balance. Vibrations from any cause give very much the same effect, and it is sometimes very difficult to determine what is the cause of the disturbance.

I have seen a machine lined by shifting the shield and then turning the machine by hand. If the machine did not turn freely, the shield was shifted again, and so on, until the machine could be turned freely by hand all the way round at the same pressure. This is a very easy method, as it is not necessary to take down any part of the machine, except to take off the grating on the top and loosen the bolts holding the shield.

If the bearing is suspected of loosening, and causing the vibration, try it by feeding an oil heavier than that generally used. The heavy-body oil will take up more room than the thin oil. A little experimenting with light- and heavy-body oil will give an idea whether the bearings are loose enough to do any harm, and which ones are the most out. Only the middle and top bearings can be experimented on in this way.

If the machine is out of balance, get the thread end of four bolts that will screw into the screw holes in the top end of the field. These are usually tapped for 1¼-inch. Cut these bolts off 2, 3, 4 and 5 inches long, respectively. Then screw one of these bolts into one of the holes in the top of the field and bring the machine up to speed, noting whether the vibration is better or worse, and change the position and size of the plug accordingly.

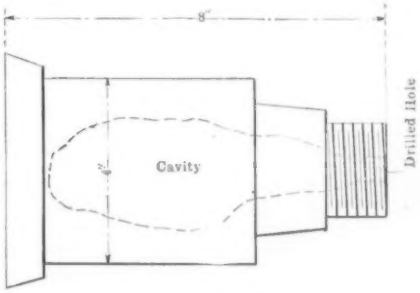
The way to tell the amount of vibration when the machine is up to speed is to go on top and place your head against the governor dome and look at some object across the room. When the machine vibrates badly, it makes the object look very wide; an improvement in the vibration will make it look narrower.

JAMES W. MORGAN.

Galesburg, Ill.

## A Peculiar Wristpin

Having occasion to equip a tandem-compound engine with the telescope or Buckeye wristpin oiler, a peculiar condition of the wristpin was discovered.




A PECULIAR WRISTPIN

The pin, shown in the illustration, is 4 inches in diameter at the bearing and 8 inches long. It received oil through the upper crosshead shoe and a small pipe leading down to the oil hole in the top of the rod.

In order to attach the oiler, it was necessary to drive a ½-inch hole, 4 inches deep, from the outside through the center of the pin, for a hollow stud which connected the ends of the telescoping arm through which the oil is fed to the center

of the bearing. In doing so, the drill, after going through about ½ inch of solid metal, dropped in the length of a full-sized lead pencil. The pin was found to be hollow almost its entire length, the cavity being nearly 2 inches in diameter, leaving nothing but a shell.

The pin was turned by one of our machinists from the stub end of an old car axle, and did not show any defect until we drilled into it. It had been in continual use for about one and one-half years with the hardest kind of service. Another pin was, of course, made to replace it.

W. D. RANNEY.

Columbus, O.

## Composite Power Generation

In the November 10 number, A. T. Kasley's article and the editorial on "Composite Power Generation" give rise to the following questions:

1. Will it pay to economize the waste heat of the internal-combustion engine (gas engine)?

2. How shall the jacket heat be turned into kinetic energy?

The answer to the first query is, it depends on circumstances. Mathematics aside, here is the simple fact: The internal-combustion engine uses up approximately one-third of the caloric value of the fuel, and the jacket water and exhaust gases consume approximately one-third each, it being presumed that combustion is practically perfect in the engine. Now this two-thirds part of the heat units is about as much as is usually generated in open-atmosphere steam-power furnaces; and with most boilers in common use, allowing for air dilution, about one-third of that heat usually escapes. With the advantages of a forced travel of the gases through impervious tubing, the draft being produced by the scavenging action of the engine, and with right arrangements of heating surfaces, and for gas and water travel and cooling of the feed water, substantially all of this heat can be turned into steam of any pressure desired. The structure needed to secure this steam pressure costs about one-half what an ordinary steam boiler and its furnace would cost that is capable of doing the same work; and this special economizer-boiler would be run absolutely without cost of fuel. If it pays to buy steam-power plants costing untold millions for installation, and run at fuel costs immeasurably greater, why would it not pay to invest in a rightly constructed economizer for utilizing the waste heat of the internal-combustion engine?

There are various reasons for not making such investments, such as complexity, inconvenience of handling, lack of space to install, requirements as to portability, as well as the requirements of increased intelligence in the understanding of such a plant. If the plant is a small one, the saving effected might not make it worth the while to effect the saving; but in large installations, especially in stationary plants, it becomes very much worth while, especially if the heat of a plurality of engine units can be economized and utilized in one boiler and one turbine, or other prime mover. It should be remembered that to the direct pressure of the steam in the prime mover, the exhaust pressure secured by a condenser can be obtained; furthermore, and what is not known as a rule, a large part of the heat which passes through the condenser, no matter what the type of that condenser may be, can be used regeneratively in a properly designed system. Also, there are advantages of a mere mechanical nature which should not be ignored in many cases, owing to the advantages of utilizing the cleanly, heat-absorbing and heat-retaining steam as a power accumulative, smooth-flowing, tractable energy-transmitting medium. There are many ways in which the energy created in a gas engine cannot be satisfactorily communicated to the driven mechanism without the interposition of steam.

This is a question that must be considered in connection with the co-active economies that are made possible through the composite generation of power. But this possibility can only be carried out with proper structural design of the co-active elements. Old methods of economizing have not been encouraging because of backwardness in structural evolution to secure these results. It is a question, also, that should be considered in cutting down costs of power through the use of low-cost fuels that could not be otherwise used. The future uptodate power-generating system requires steam as at least a factor in the running of the system, and as long as steam has got to be used, there is no reason why it should not be created from heat that is now absolutely wasted. In locomotive work and marine propulsion, no satisfactory efficiency in the use of fuel can be reached without the composite generation of power.

The management of the jacket-water heat to secure a maximum efficiency and to prevent damage to the engine, requires special structure in the engine, involving the application of several new principles that are now not applied. It requires high pressure given to the jacket water, and progressive heating of the water, as well as its positive circulation.

The matter of concentrating the heat of the jacket water is effected by simply giving the jacket the work of a primary heating of the water, and then further heating the water with the higher heat of the exhaust gases.

J. M. W. KITCHEN.

East Orange, N. J.

## Motor Troubles

C. S. Norman, on page 663 of the October 20 number, speaks about his cast-iron strips holding the field coils of his compound-wound motor breaking by giving way on the bottom fields. I believe the breaking is caused by the current in the armature, when there is a heavy load on the motor, pulling with such a strong magnetic force as to cause those bottom field coils to pull up hard against the cast-iron strips. The fields may also be a little loose on the pole pieces, so that when there is no current in the motor they slip down, but as soon as the current is turned on they come up against those strips with a slight jerk, causing the strips to crack.

THOMAS GORDON.

Chemawa, Ore.

## Remedies for Gas Engine Troubles

In an article on "Remedies for Gas Engine Troubles," which appeared in the October 21 number, Mr. Klepinger's statement that opening the inlet and exhaust valves when shutting down will prevent water from accumulating in the cylinder is rather broad, because some engines are built with a packed joint between the water jacket and the cylinder, and any leak at this point could be remedied only by repacking.

These leaks may be so small as to give very little trouble even when starting up, or they may be large enough to be noticed by the way the water is discharged from the jacket, being not unlike the discharge of a pump. In the latter event it would be practically impossible to start the pump.

His advice to mark the teeth on the gears when dismantling a gas engine is good and to the point, but marking should include not only the 2-to-1 gears, but all other gears which may be on the engine. If the gears are fastened to the shaft with set screws and have removed on either or both the main and parallel shafts and have not been replaced exactly, the marks would be worthless and misleading when assembling.

I consider it a good idea to mark the teeth so as readily to replace gears when necessary to dismantle parts in order to make quick repairs.

I always change gears so as to bring the wear on different parts, because the nature of the work is such that the gears practically run idle excepting when operating the exhaust valves, and this throws the bulk of the work on the teeth that are in action while the valve is opening, so it is plain that nearly all the work is thrown on four or five teeth. By turning the gears on the shafts, the life of the gears can be greatly prolonged. This is especially true of fiber or rawhide gears.

GEORGE H. BRAND.

Findlay, Ohio.

## Effect of Scale in Boilers

Many statements have been made, regarding the effect of scale in boilers, that are accepted by engineers without question, one of which I would like to see discussed.

Those who have tube-cleaning devices and boiler compounds to sell tell us that 1/16 inch of scale will cause an increase in fuel consumption of from 12 to 15 per cent., depending on the character of the scale. If this is so, I should think it would pay some enterprising concern to make up scale in some suitable form for pipe coverings, instead of using magnesia and other substances. A steam pipe with a covering 1 inch or more in thickness would look much neater so coated.

If the loss with 1/16 inch of scale is so great, it would be interesting to know where this heat goes to. Does the boiler setting absorb more heat than it would otherwise, or is the loss entirely accounted for by a rise in the temperature of the escaping gases?

Delicate experiments can be made which will demonstrate the relative conductivity of scale and iron, but in actual practice, with which most of us are chiefly concerned, can it be truthfully stated that 1/16 inch of scale will make the difference claimed?

F. Hilton Williams.

New Haven, Conn.

## A Friction Governing Device

It was required to run an engine at speeds varying by about 25 per cent., and to govern accurately at all speeds. In order to keep the governor speed constant, the following device was adopted:

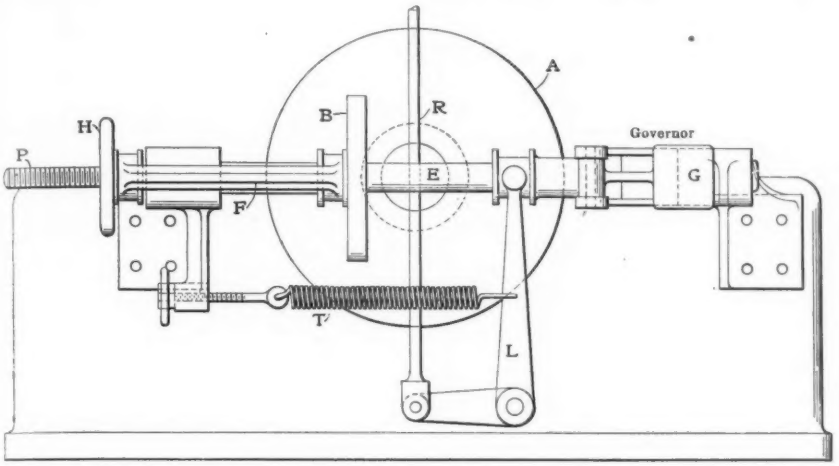



FIG. 1

Elevation and plan views of the arrangement are shown in Figs. 1 and 2. A large leather-faced friction disk *A* was made to rotate with the crank shaft and to press, by a light spring pressure, against the disk *B*, which was movable longitudinally in a spline on shaft *E*, to which a centrifugal governor *G* was also keyed. By means of the threaded pin *P*, handwheel *H* and arm *F*, the disk *B* could be moved to any desirable position on the periphery of *A*, thereby adjusting the governor speed correctly for any variation in the engine speed.

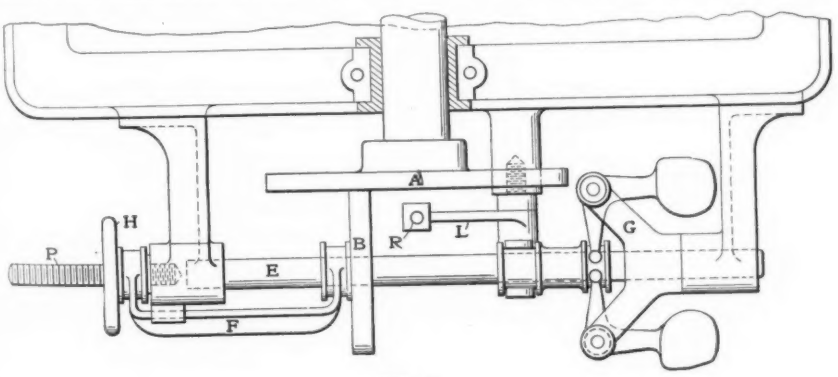



FIG. 2

The throttle rod *R* was moved by the governor through the bell-crank lever *L*. The engine speed could be adjusted by the tension spring *T*. This arrangement was very simple and satisfactory.

E. Herst.

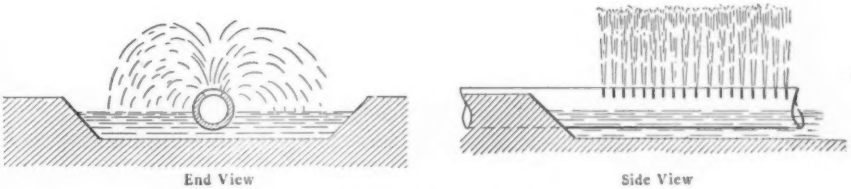
England.

## Spray System for Condensing Purposes

Having noted in a late issue an article on this subject, I write to inquire if any reader has ever used the spraying system illustrated, and if so, with what result.

The water to be cooled is forced by the air pump into a central horizontal pipe containing transverse slots, from which it is ejected upward in thin sheets, which in turn break into spray as they fall to the pool. A head of 15 feet will give a spray about 8 feet high, and the water cools both in its upward and downward paths, thereby gaining considerable time for evaporation and radiation.

Again, as the spray is only formed as the water falls, there is less likelihood of its driftage and loss, and a large quantity can be handled in a small area, and at low first cost. Granted that the addition of a condenser is not commercially advisable in every case, and generally only available during the summer, there still remain a large number of plants, with slow-speed engines, where a vacuum would pay large returns on the investment, both in coal and purchased water. The evaporation is far less than the difference in steam consumption between condensing and noncondensing, and there is a steady gain of pure water to the pool from the condensed steam.




MR. EMERSON'S SPRAY SYSTEM

M. Emerson.

Boston, Mass.

## The Lever Safety Valve versus the Pop Valve

On a recent visit to a boiler room located in the basement of a fair-sized hotel, the writer noticed that every time the safety valve blew, which apparently was about every fifteen minutes, the fireman hung his clinker hook, slice bar, or other available piece of boiler-room furniture on the end of the lever until the boiler cooled down enough to prevent further blowing, when he would remove the excess weight and proceed to boost the pressure up to the blowing-off point again. After learning the weight of the slice bar, which was the usual extra ap-

pendage to the lever in these emergencies, it was calculated that the added weight raised the blowing-off pressure to 145 pounds per square inch. The allowable pressure, and the pressure at which the valve blew under the weight of the ball alone at the end of the lever, was 80 pounds. What the probable consequences would be, if the fireman, or one of his numerous substitutes on the job, should at any time forget to remove the bar and continue to fire by the sound of the simmering safety valve, can only be conjectured. The conditions were certainly all present and ripe for another "mysterious" boiler explosion.

The safety valve, as its name suggests, is the principal safeguard against disaster from overpressure, and as such, it is by far the most essential adjunct to a steam boiler. Long familiarity with this very necessary appurtenance, however, if it does not really breed contempt, very often engenders a sort of carelessness and indifference not at all in keeping with the importance of the apparatus. To the average boiler fireman, the safety valve is not a factor of very great moment in the operation of the plant; but to the confiding citizen who lives, sleeps, or transacts business in a building located over or near high-pressure steam boilers, the safety valve is the one assurance he has, aside from the skill and vigilance of the engineer and fireman, of remaining whole and intact in the event of an overpressure of steam.

The attitude of the average boiler attendant toward the safety valve does not make much difference in the case of a well designed and correctly proportioned spring-loaded valve that has been accurately adjusted to the pressure by an inspector or other in authority, and then locked up to prevent meddlesome interference, but it certainly is a matter of very grave moment in the case of a lever valve with the opportunity afforded for malicious or ignorant tampering, not to mention the extreme liability of such a valve to become stuck and inoperative at a critical time.

Regarding this matter of the valve corroding and sticking to its seat, it might be said that the spring-loaded valve cannot be altogether infallible; but even so, the chances of the usually well designed and properly constructed pop valve, with its noncorrosive valve and seat, performing in such a manner are very remote.

The lever safety valve is in common use on stationary boilers in localities where its use is not restricted by law, simply because it is cheaper than the pop valve. It costs less to buy a lever valve than it does a pop valve, but, leaving out of consideration the danger attendant on its use, it is likewise far less efficient than a pop valve—is, in fact, not within 50 per cent. as efficient.

With the same area of valve orifice and the same pressure of steam, a pop valve will give more than three times the area of opening when it lifts for the escape of steam, that a lever valve will give. Besides, the pop valve is operative within a much narrower range of pressures, will open and close quicker, and thereby save the steam that a lever valve would waste.

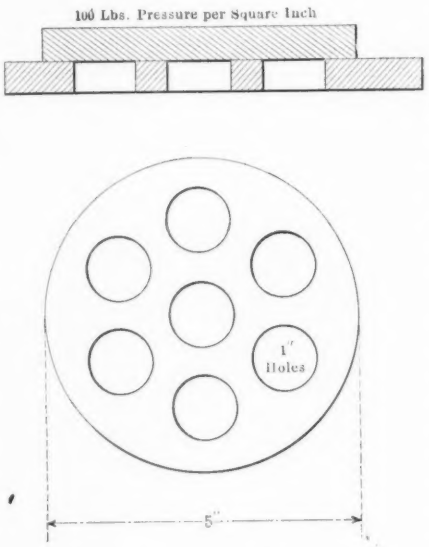
For the various reasons here set forth, every lever safety valve ever designed for use on a steam boiler should be relegated to the scrap pile, and a good, substantial, spring-loaded, well armored and locked-up pop valve should be substituted in its place.

H. J. Dixon.

Chicago, Ill.

## Requisite Pump Pressure

George H. Anderson, on page 702 of the October 27 number, brings out a very interesting point relating to valves, namely, that the pressure on the top, or discharge side, of a valve is the pressure




HOW MUCH PRESSURE IS REQUIRED TO LIFT VALVE?

per square inch multiplied by the area of the passage, plus the area of the valve seat; the pressure on the under, or admission, side of a valve is the pressure per square inch multiplied by the area of the passage only. Supposing, therefore, the valve seat to be counterbalanced, or without weight, it would still require a considerable increase in pressure per square inch before it would open, the increase being directly proportional to the area of the valve seat.

I must admit that it has never been my experience in practical work to notice any falling off in pressure the instant a check valve or delivery valve has lifted from its seat, and I have watched pressure gages while a very slow-moving stream of water has gradually built up pressure against a delivery valve and finally opened it and leaked through and I never noticed a sign of a backward motion. The pointer crawled around until the pressure had reached the point where the counter-resistance was overcome and the water leaked through while the gage remained motionless. Of course I was not looking for any decrease in pressure; in fact, I never anticipated any.

I would like to get some opinions as to how much pressure per square inch it would take on the delivery side to lift the 5-pound valve shown in the illustration, supposing the pressure on the receiving side to be 100 pounds per square inch.

George P. Pearce.

Exeter, N. H.

## Durability of Batteries

In reply to R. Manly Orr's question as to the durability of batteries used for gas-engine ignition for different speeds, I would say that it depends on the timing device. This is usually constructed so as to complete the electrical contact for a certain proportion of a revolution of the engine, and, therefore, a constant proportion of the time the engine is running regardless of its speed. That is, the batteries should last just as long at high speed as at low speed. One igniter company claims a consumption of one ampere per hour, on closed circuit, for its jump-spark system. Other makes of spark coil may be different.

If the timer of the engine makes contact for one-eighth of its revolution, or one-eighth of a cycle, for either a two- or a four-stroke engine, a battery consumption of ⅛ ampere per hour must be expected. If dry batteries are used which test at 27 amperes, and are run with a fair upholding of the voltage to 6 amperes, 21 ampere-hours are available. At a current consumption of ⅛ ampere per hour, 168 running hours of the engine can be expected.

On a small high-speed engine run by the writer, the timer has a contact of about one-fourth revolution, which, although it uses the batteries faster, no doubt gives better explosions on a weak or varying strength mixture, caused by a leaky or unreliable vaporizer. On a recent run of 1½ hours, with new batteries, a consumption of about ½ ampere was noted. In another run just previously, the batteries were run from 6¾ to 5¼ amperes in 2½ hours, attended by some misfiring. It was also necesary to use a very rich mixture on account of the weak spark. Therefore, the current consumption increased as the voltage dropped. Good dry batteries are supposed to give a fairly constant voltage until run down to about 6 to 9 amperes capacity.

M. Dwight

New Haven, Conn.

# James P. Allaire and the Allaire Works

## Some Interesting Facts Concerning an Early Steam Engine Industry and Its Founder, Who Started as Robert Fulton's Successor

BY EDWARD P. BUFFET

Veterans among our American engineers can remember the day when New York City was a metropolis of steam-engine construction. Especially was it eminent in marine work. At the time of the war between the States there were flourishing several large shops which had built up a national reputation. Among those that were doing great things then or somewhat earlier may be named the Allaire Works, West Point Foundry, Novelty Iron Works, Speedwell Works and the Delamater Iron Works. None of these was, at one period, more famous or influential than the Allaire Works, which dated back from our time about a hundred years. As a machine shop it was an outgrowth of Robert Fulton's establishment.

James P. Allaire, a descendant of an old Huguenot family, was originally engaged in the avocations of a drug store, which he relinquished to start a brass foundry. It was situated on Cherry street, near Corlears Hook, New York, on the extreme east side of the city, not far below the present Williamsburgh bridge. The date of his entry upon that business is stated in Charles H. Haswell's "Reminiscences of an Octogenarian" as 1813, while Bishop's "History of American Manufactures," written about half a century ago, gives the year as 1804. Bishop is not remarkable for mathematical precision and since Mr. Haswell was employed by Allaire in very early days, he ought to be the better authority. We may, however, admit Bishop's chronology in evidence and it is upon him that I depend chiefly for the account given of Allaire's relations with Fulton and his subsequent doings.

### Fulton and His Contemporaries

In 1807, as all men know, Robert Fulton demonstrated the practicability of the steamboat idea by the famous voyage of the "Clermont," whose engines and boilers had been furnished by Boulton & Watt. Soon afterward he erected a shop on or near Greene street, Jersey City, in a locality later marked by Zeno Secor's "Fulton Iron Foundry." There he built engines for the "Car of Neptune" and other vessels. The iron castings were supplied by Robert McQueen and John Youle, the brass castings by James P. Allaire.

This McQueen, in conjunction with a Mr. Sturtevant, ran an air furnace at the corner of Barley and Cross streets, New York. He is thought to have been the first man in America who made the building of stationary steam engines a specialty.

Fulton's exploits became to Allaire the inspiration and stimulus by which he grew into a great engineer. He gave his heart to the improvement and simplification of the steam engine and upon his shoulders fell the mantle dropped at Fulton's early death.

### Establishment of the Cherry Street Machine Shop

When, in 1815, the father of steamboat navigation died, Allaire leased his shop and tools and took into partnership his engineer, Charles Stoutinger. They proceeded to construct the engine and boiler for the famous "Chancellor Livingston," which occupied about a year of their time to complete. With a cylinder of 40 inches diameter and 4-foot stroke, the boat developed a speed of eight miles per hour. In a short while Mr. Stoutinger died, leaving to his partner a legacy of prediction that marine engines would be greatly simplified and that ships would cross the Atlantic within eleven days' voyaging time. Allaire removed the machinery and tools, in 1816, from Jersey City to Cherry street, New York. Thereby he definitely laid the foundation of the Allaire Works, whose annals are a record of achievement in equipping many of the famous vessels of their day.

### Progress of the Allaire Works

Among the first work done was to repair the "Savannah," whose machinery had been constructed elsewhere, and which, in 1819, made the first voyage across the ocean. Her original cylinder, 44 inches in diameter with 5-foot stroke, was exhibited as a relic at the New York World's Fair of 1853. She is the vessel of which is told the hackneyed story that on her first trip she brought copies of a demonstration that it was impossible for any ship to carry coal enough for such a voyage.

Among engines early built by Mr. Allaire were those for the "North Carolina," "South Carolina" and "Robert Fulton." Naturally he was considerably concerned with the equipment of the North river steamboat service.

The boilers of these early boats were made of copper, since iron was not available in suitable quality and was believed to be lacking in strength for that purpose. Wood was burned as fuel and a brilliant sight it made for spectators on the shore of the Hudson as the steamers paddled along at night.

### Burning Anthracite

When anthracite began to come in use it met with contemptuous opposition from the skeptics, who would not hear of burning "black stones." Two of the first to use it for steamboat purposes and otherwise were R. L. Stevens and the Rev. Eliphalet Nott, president of Union College. James P. Allaire was another anthracite pioneer. By his insistence the "Car of Neptune" was laid up and her furnace equipped with grate bars adapted to stoking with that fuel. The firemen of the boat went on strike to vindicate their superior knowledge, so Mr. Allaire volunteered to act himself as chief fireman, taking along some men from his own shop as assistants. In 18 hours the steamboat reached Albany, thus achieving a triumph only slightly inferior in importance to the maiden trip of the "Clermont." But a "man convinced against his will is of the same opinion still," and so it proved with the steamboatmen of that day, who continued to burn wood for some time thereafter.

### Rapid Growth of the Works

The Allaire Works grew, by the year 1831, to employ 200 hands. Beside this, Mr. Allaire was employing 400 in a furnace and foundry plant which he maintained among the New Jersey pines. The New York shop then turned out in six months engines and other heavy iron work to the value of $140,000.

After continuing the business as a personal one until 1842, Mr. Allaire turned it into an incorporated company, with a cash capital of $300,000. For eight years he served as president, retiring in 1850. He was succeeded by T. F. Secor. Mr. Allaire had been a most painstaking manufacturer, instructing his men to reject faulty castings and allow no piece of machinery to pass muster unless perfect of its kind.

After his retirement the works continued to turn out large work and were one of the most important shops. At the time of the interstate war they occupied a teritory of fifty-two 25x100 lots and employed about a thousand men, producing annually an output estimated at

$1,000,000. Among their record-breaking work was the beam engine for the steamship "Vanderbilt," with two cylinders 90 inches in diameter and 12-foot stroke. Another job was a propeller engine with 100-inch diameter by 4-foot stroke cylinder for the Ericsson monitor "Puritan." They also constructed some stationary machines, including a Cornish engine for the Cleveland, O., waterworks and pumping engines for New Orleans.

### Allaire in the Jersey Pines

The great shop on Cherry street was not the only important interest that bore the name of Allaire. In the vast and lonely pine region of New Jersey he maintained a furnace plant through which his memory is today kept greener than by reason of the New York establishment. The wilderness of South Jersey is today a graveyard for the dead bog-iron ore industry, whose forges and furnaces, a century ago, instilled a now almost incredible amount of prosperity into that solitude of nature. About the year 1812 Mr. Allaire acquired possession of an existing ironworks on the Manasquan river, a few miles back from the coast on the northern border of the bog-ore region. This plant he enlarged, for furnace and foundry purposes, expending thereupon, it has been asserted, half a million dollars. Here was built a thriving village, containing the mansion house of Mr. Allaire, at which John Roach, the shipbuilder, found his bride. With the decay of the Jersey iron trade, about the middle of the last century, the Allaire works ceased operation. The outward habitations of industry and life did not at once fall to ruins, but year by year have sunken into quietude and decay, remaining to furnish a melancholy commentary upon the impermanence of manufacturing success. At a comparatively recent date, if not at present, the little chapel at the village was still kept up, and Henry Allaire, son of the great engine builder, was still a lonely occupant of the old mansion house. But the very desolation of the place has tended in a way to revive it. Of late years it has become famous as a "deserted village" and is growing to be a favorite objective point of sightseers from neighboring resorts on the coast. Thus it is evidently being vulgarized by the picknickers and beer-bottle throwers in the same manner as the site of Thoreau's hut by Walden pond at Concord, Mass., and like all other localities of refined appreciation when they become a popular fad.

### Unpublished Notes of Charles H. Haswell

That patriarch of the engineering profession, Charles H. Haswell, who died May 12, 1907, in his ninety-eighth year, having continued in active business up to the time of his death, was, by the aid of his memory and memoranda, a link with the remote past quite beyond parallel among living men. A few years ago, while I was engaged in some research, he supplied me with several manuscript notes which, so far as I am aware, have not hitherto appeared in print. Since they relate to James P. Allaire and his engineering contemporaries this is a proper occasion to present them in full:

"James P. Allaire was originally in a drug store and at the period of Robert Fulton's essays he engaged in the foundry business and soon extended it to the manufacture of steam engines, boilers, etc."

"In 1828, William Gibbons, of New York, who had the monopoly of steamboat service between New York and New Brunswick, lost it by an act of the New Jersey Legislature and in withdrawing his boats he gave to Captain Vanderbilt the steamboat 'Bellona.' This was the first and only boat the captain owned, and in May he contracted with Mr. Allaire for the building of the 'Citizen.'"

"In March, 1828, Charles H. Haswell, subsequently the first chief engineer and the first engineer-in-chief in the naval service of the United States, entered the employ of James P. Allaire. In 1837 he designed and built the first steam launch."

"William Lighthall was a fireman on board the 'Chief Justice Marshall,' and he and Henry (R.?) Dunham, a journeyman silver plater, simultaneously, in 1829, entered the fitting shop of James P. Allaire at 75 cents per day."

"The 'West Point Foundry Association' was organized in 1816, for the casting of cannon and subsequently commenced the manufacture of steam engines and boilers in West street, corner of [Beach] street, New York."

"John Conroy, the well known manufacturer of fishing rods, reels, etc., was an expert and ingenious finisher in metals, and in about 1830 opened a store in the gore on the southeast corner of Fulton and Cliff streets."

"John Clark, a millwright, designed the lining of the air pump of a marine steam engine with staves of brass, expanding them by the repeated blows of a button-headed hammer and then boring out the cylinder."

"Hogg & Delamater commenced business in the open air at the foot of Harrison street, North river, and * * * removed to the foot of West Fourteenth street."

Bishop tells us that the works at the foot of Thirteenth and Fourteenth streets were founded in 1850, the firm of Hogg & Delamater having existed since 1842 at the Phoenix Foundry, on West street, between Hubert and Vestry streets. Mr. Hogg retired in 1855 and the business was thereafter conducted by Cornelius Delamater alone. At these Fourteenth street works was constructed the machinery of Ericsson's original "Monitor." They were in existence up to a few years ago as a survivor of the old New York engine shops. In fact, the name of the works still remains in the business world. The West Point Foundry before alluded to, is now and has long been located at Coldspring, N. Y.

The Phoenix Foundry dated back to 1835. Previous to 1842, it had been conducted by James Cunningham, who was the first to cut off steam by the detachment of an inlet steam valve; this was an invention of Peter Hogg, his apprentice, in 1839. (Bishop.)

To Mr. Haswell's manuscript notes may be appended three relating to Mr. Allaire extracted from his "Reminiscences of an Octogenarian:"

(1816) "James P. Allaire, who had commenced business as a brassfounder in the year 1813 in the upper part of Cherry street, No. 434, had so extended his business under the patronage of Robert Fulton and the elder Gibbons, that he became the leading manufacturer of steam engines, boilers, etc. The famous name of the Allaire Works was to be seen on a vast number of engines, especially on steamboats, at a time comparatively recent."

(1824) "In this year, James P. Allaire, the proprietor of the largest steam-engine manufactory in the United States, located on Cherry and Monroe between Walnut (Jackson) and Corlears streets, designed and constructed the engines of the steamboat 'Henry Eckford,' which were of this compound type, being the first of the kind built in this country or applied to marine purposes in any country; subsequently, 1825 to 1828, he constructed those of the 'Sun,' 'Post Boy,' 'Commerce,' 'Swiftsure' and 'Pilot Boy.' It was not until more than thirty years after (1860) that the English engineers revived this type of engine, introducing it in all their steamers and land engines with the improvement of a steam receiver intermediate between the cylinders, and operating with a much higher pressure of steam."

(1832) "The writer suggested to his former employer, James P. Allaire, the steam-engine manufacturer, that, as work was light, it would be well to keep all his good men and build a tugboat, which he might employ profitably if he could not sell her. To which he replied: 'Why, Charles, there are three now!' This was considered conclusive; three boats, how could they be supported? At the present time (1895) there are 592 documented at this port, besides an unknown number from outside our limits."

---

In comparison, 57.25 pounds of coal or 63 pounds of coke is equal to about 1000 cubic feet of natural gas. Producer gas made by the partial combustion of coal to carbonic oxide is a lean gas composed of about 25 per cent. CO and about 60 per cent. of nitrogen. The calorific value is about 150 B.t.u. per cubic foot.

## Burning Gas under Steam Boilers

By A. R. Munzer

We have six 72-inch by 18-foot return-tubular boilers, and one 350-horsepower water-tube boiler. We have used gas more than one year and are well pleased with it, as we find it more economical and much less trouble than coal. Having Roney stokers gave us some concern at first, as we did not wish to change the furnaces to such an extent that it would take too long to get ready to burn coal in case the gas failed.

The furnaces are about half filled with old brickbats, leveled off with sand and paved with firebrick. A checker wall of firebrick is built up to within 6 inches of the boiler shell, and about 3 feet from the end of the burners.

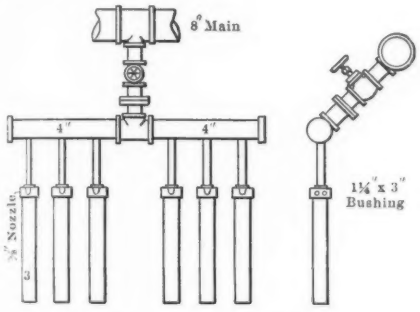



FIG. 2. GAS BURNER

The burners were first bricked in air-tight, but we could not obtain complete combustion, through lack of air, so an opening was made under each burner, which was a decided improvement. This permits air to pass up directly in front of the burner and mix with the gas before combustion takes place. We get the best results with the dampers in the stacks wide open, have no smoke and seldom, if ever, clean the flues. The ashpit doors were bricked up tight, and the doors in front of the grates removed and a frame with tilting doors fitted tightly; when these doors are closed the ashpits are practically air-tight. Fig. 1 shows the arrangements of the burners and tilting doors.

A butterfly valve in the 8-inch gas pipe between the gas regulator and the boilers is controlled, together with the air doors, by a regulator. To make the regulator, we used part of an old damper regulator, which was formerly used in connection with dry cells, and connected it up as shown in Fig. 3. It does the work, as may be seen by the steam chart, Fig. 4. As our load is very fluctuating (rolling mill), the chart makes a good showing.

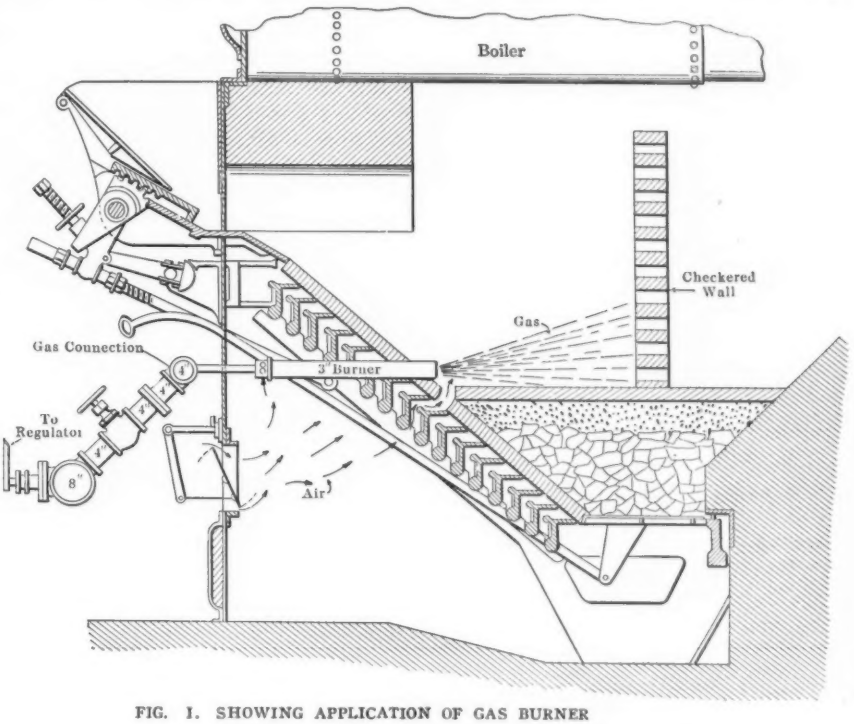



FIG. 1. SHOWING APPLICATION OF GAS BURNER

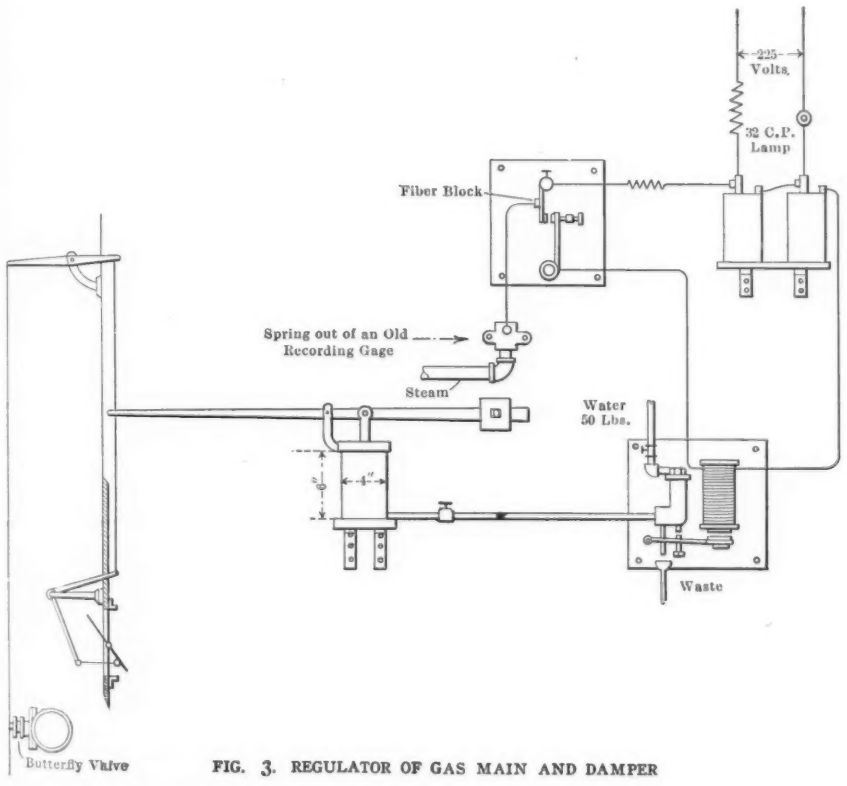



FIG. 3. REGULATOR OF GAS MAIN AND DAMPER

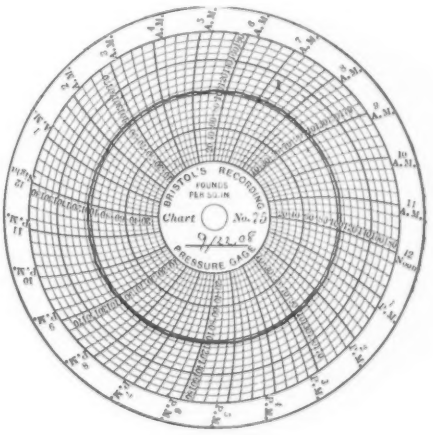



FIG. 4

An 8-inch gas main runs along directly in front of the furnaces with a 4-inch connection to each furnace. The burners are made of gas pipe, Fig. 2, and inserted through the grate bars into the furnace.

There are now six complete movable dams on the upper Ohio river extending from Pittsburg below the mouth of the Beaver river. They are the first ones in operation of the series that has been projected.

# POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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## Hard or Soft Condenser Tubes

Condenser-tube troubles are always with the operating engineer, and there appears to be no certain remedy. It has been brought to our attention that the question of "hard" versus "soft" tubes may have much to do with the deterioration and life of the tube. It is customary with the manufacturer to furnish tubes which are not "dead soft," but which have had a slight draw after the last annealing on account of the difficulty of handling, shipping, and installing a dead soft tube. Tubes so soft as to deform during the process of packing are not used to any extent.

Should we use hard tubes? At first sight it would appear that the harder metal would be stronger and would better resist corrosion; the softer tube deforming, and with its open grain being much more likely to be acted upon by the chemical impurities in the circulating water. There are many recorded instances of deterioration of condenser tubes in which the tubes are known to be hard, but none that we know of where the softer metal was used. Perhaps some of our readers can suggest the reason.

## Power Plant Output Records

How many power or lighting systems of less than ten thousand kilowatts output are provided with adequate means for keeping reliable records of output and the corresponding operating expenses? There may be numbers of such stations for all we know, but we haven't seen them. A station equipped with a recording voltmeter, a recording ammeter and perhaps a recording watt-hour meter on the total-output panel will usually be devoid of a recording wattmeter. Another station will contain a recording wattmeter and no watt-hour meter, in another the recording voltmeter is supreme in its loneliness, and so on. At the other end it is usually as bad; no means for keeping accurate records of coal and water consumption are provided, as a rule. A small platform scale and an ordinary water meter in the city water connection are, ordinarily, the equipment provided; if water is taken from a convenient stream or a well on the premises, it is pumped to the boilers without measurement.

The peculiar feature of all this is that the manager or other official responsible for the operation of the plant will freely admit that an automatic coal-weighing machine and the necessary recording instruments "should have been put in, but"—and that is as far as you get. When an effort is made to ascertain the average operating economy of the outfit, the coal company's bills and some haphazard readings of switchboard instruments, made at uncertain intervals by a possibly irresponsible youngster, are put forward as the basic data.

No matter what other instruments are or are not provided, every station should have in regular service reliable means for measuring and recording the coal fired under the boilers, the water fed to them, the voltage fluctuations of the electrical system, the fluctuations of the power delivered to the distribution system and the energy in kilowatt-hours delivered to it. However, all of these are valueless unless they are intelligently used. A station log should be kept on which all records are inscribed and the arrangement of the entries should be such as to show almost at a glance the relationship between cotemporaneous records of coal, oil, etc., and of output. Rather trite advice, if not actually platitudinous, you will say. Perhaps; so is the admonition to avoid over-cordial strangers on one's first visit to a metropolis, ignoring which costs foolish persons many thousands of dollars annually.

## Retire the Lap Seam Boiler

In the September 8 number of POWER AND THE ENGINEER there were published selections from lists of questions which had been asked by inspectors and examiners in different parts of the country. Readers were invited to send in answers to these questions; that is, to take an "absent-treatment" examination. Responses were numerous, were in the main correct, and the poorest received would entitle the engineer to "pass."

Larger diversity of opinion showed in the choice of style of boiler joint and thickness of plate than in anything else, some feeling satisfied with the fitness of the double-riveted lap seam, while others specified the double-strap butt joint with four rows of rivets and an efficiency of joint of ninety-four per cent. This variety of opinion as to the style of joint and pitch and diameter of rivets made a difference in the thickness of plate selected from five-eighths to three-eighths inch. The style of joint selected, of course, determined the thickness of the plate.

With sheets of the same tensile strength one selects a double-riveted lap seam having an efficiency of seventy per cent., while another chooses a double-strap butt joint having a strength equal to ninety-four per cent. of the whole plate. The one is forced by the nature of the joint taken to use plates one-half inch thick, while the other designs an equally strong boiler using plates three-eighths of an inch thick.

Inspectors and others might question the judgment of the engineer who would specify the double-riveted lap seam in a boiler of any size to be used for one hundred and twenty-five pounds pressure, but he could not criticize the mathemati-

cal reasoning by which the conclusions were reached.

It is not contended that for a constant load the lap seam is unsafe, but with this kind of a joint the boiler, being out of round, changes shape with each change of pressure and the movement is localized at the joint, producing the hidden cracks which have been the cause of the explosion of so many boilers that had been recently inspected. It is impossible, without unmaking it, to determine the condition of such a joint that has been in use for some years; but the fact that it is impossible to say whether a joint is safe or unsafe makes it imperative that it be called unsafe. This has been recognized in the Commonwealth of Massachusetts, where the lap-seam boiler has been practically legislated out of existence—an example of common sense and care for public safety that should be immediately followed by other States, even if no further legislation along this line is contemplated.

## Unintentional Improvements

In details good engineering, like good marksmanship, is often the result of chance rather than premeditation. It is, however, rare that such occurrences become known, as it is human nature for the one to whom the credit is given to look wise and refrain from divulging the true state of affairs. The following is an actual occurrence of this kind which happened to a manufacturer of boilers:

A patron, who was located at a distance of twelve hundred miles, had purchased at a previous date several return-tubular boilers. He had ordered these from the manufacturer's catalog of standard boilers, which were arranged with fronts of suitable hights for burning coal. It happened that slabs were used for fuel in this plant, but as the purchaser had never seen a setting arranged for this kind of fuel, he imagined that the setting was all that could be desired. The boilers and attachments were of the best and the purchaser was so thoroughly pleased that when an increase in load demanded additional boiler capacity a repeat order was sent to the manufacturer for two more boilers.

Some time previously another patron of the same manufacturer had ordered some special fronts, arranged so the boilers would set very much higher above the grates than usual, and with a double tier of firing doors. For some reason two of these special fronts were left on the manufacturer's hands, and they were placed in the yard in the hope that some day a purchaser could be found. As the manufacturer daily passed by the fronts to and from the office, he made mental calculation as to the amount he was losing on the investment.

When the order came in for the two new boilers, regular fronts were got out as before, and while waiting for the completion of the boilers so that one shipment could be made, they were placed in the yard beside the special high fronts. In due time the boilers were completed and through mistake the special high fronts were shipped with them instead of the ones intended for the job. This mistake was not discovered until about a week later, when the manufacturer happened to miss his old friends, and immediately inquired who had purchased the monstrosities, when investigation proved that they had been shipped with the order.

After visions of a wrathful purchaser had passed before his mind, and the tension had been somewhat relieved by roundly "calling down" everyone who had a hand in the mistake, the manufacturer began to compose a reply to the hot letter which was expected from the purchaser in every mail. For some reason no such letter came, and it was thought that possibly the boilers had not been set up at once, but the manufacturer was loath to stir up a hornet's nest, so he waited patiently and at the end of about six weeks his patience was rewarded. He received a letter with the sawmill postmark and, opening it with a heavy heart, he was dumbfounded to extract an order, reading: "Send four more fronts exactly like the last."

Accompanying this order was a long letter complimenting the manufacturer on the wonderful benefits derived from the improved design, which proved so desirable that it was decided to reset the four old boilers at once. Did he tell the purchaser that these fronts were shipped through mistake?

## Storage Batteries for Small Sized Lighting Plants

Unsteady lights and momentarily abnormal peak loads, which are a common occurrence in isolated electric plants, unless a storage battery is included in the installation, are the "abomination" of the engineer. Unsteady lights are most objectionable to the consumer, also, and while the engineer is generally blamed for allowing a condition to exist to bring about such a fault, in reality he is not to blame at all, although he may be justly blamed for poor valve fittings, fluctuating steam pressure, or faulty apparatus, even though the machinery in the plant is in first-class condition.

In office buildings with electric-elevator equipment this trouble is more manifest than elsewhere, unless the generators are assisted in their work by a storage battery. The starting of the various elevators, singly or simultaneously, produces a momentary overload on the engine and generators, causing them to slow down for an instant, resulting in a drop in voltage and consequent dimming of the light. It is true the engine immediately recovers its normal speed, but the interruption has been enough to cause a flicker of the light. This occurrence each time an elevator is started becomes very annoying. A suitable storage-battery installation has been found to work accurately under such conditions and to eliminate the undesirable flickering. There is nothing to prevent the adoption of storage batteries in electric plants affected in this manner, as such systems may be installed to meet all demands, providing the necessary space and capital are at command.

With a suitable battery to take the peak loads, the lights are always steady, the engines are exempt from sudden shock and the entire equipment is made more satisfactory. Naturally, storage batteries cannot be set up and left to shift for themselves; they require attention. But this does not necessarily mean that an expert must be employed to attend to them, as there is no reason why the average engineer cannot become competent to care for and operate them in a very short time.

Most electrical plants situated in office buildings operate day and night. The number of men employed will be the same, and while a smaller unit may be operating during the night run, the operating expenses will not be much less than during the day. It is therefore easily seen that the engine on the night load can be utilized in charging the batteries ready for the heavy day load. As the engine is usually operating at an underload, and therefore operating uneconomically, the additional load in charging the battery is often a partial gain, as the engine is then operating with a load more conducive to economy.

Another feature in favor of storage-battery systems in small office buildings is the fact that the engine can be operated during the day and used to furnish the necessary lighting, besides charging the batteries which may be used during the night. This permits shutting down the engine after the majority of tenants have gone at night and the loads switched onto the battery system, which eliminates the expense of a night fireman and engineer, besides the cost of fuel and supplies.

A storage-battery system can be installed at any time, there being no special requirements insofar as it and its generator are concerned, as it is only necessary to make the proper connections to the switchboard. This idea has been applied in thousands of plants, and as the first cost is not excessive and skilled attendants are not necessary, there is no excuse for a continuation of the nuisance of flickering lights due to fluctuating elevator loads.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Ridgway Side Crank Engine

In order to be in a position to furnish an engine of either the center- or side-crank type, the Ridgway Dynamo and Engine Company, Ridgway, Penn., has designed a new side-crank engine, described and illustrated herewith.

The bed, as shown in Figs. 1 and 2, is of heavy design throughout, with the metal distributed so as to bring the heaviest sections in line with the greatest strains. The main part of the bed is of a box section, having bored guides of large diameter.

At the cylinder end of the bed is a removable partition provided with sectional packing around the piston rod. This prevents oil from being thrown against the end of the cylinder. Between the cylinder and the partition is a well in which the drip from the stuffing box is caught. The water is removed by a separator and the oil flows back to the crank pit.

The crank disk is covered with an oil-tight guard of light sheet steel, hinged at the top so it may be turned back over the bed, giving access to the connecting rod and crank pin. See Fig. 1.

The main bearing on all sizes is of the quarter-box type. The shells are lined with genuine babbitt, and are interchangeable in engines of the same size.

The connecting rod is forged from open-hearth steel and designed with a minimum factor of safety of fifteen. Both ends are adjusted by the wedge-and-bolt method.

The crosshead body is of cast steel, and substantial. The shoes, which are faced with babbitt, are of the cylindrical type. The upper shoe is bolted solidly to the body, while the lower shoe is adjustable.

Because of the large size of the crank pin and the shaft at the crank fit, the crank pin is cast solid with the disk.

The outboard-bearing pedestal is built on liberal lines and made broad at the base to insure stiffness. The bearing is of the self-oiling, self-alining type, the shells being lined with babbitt, peened and bored.

The valve of this engine is of the flat, balanced type. It moves between the seat and a heavy pressure plate which relieves it of all pressure, holding it against the seat. In the pressure plate are cored ports corresponding to those in the valve seat and connecting through side openings with the main ports, thus making a double-ported valve. The pressure plate is held in place by lugs on the edges and

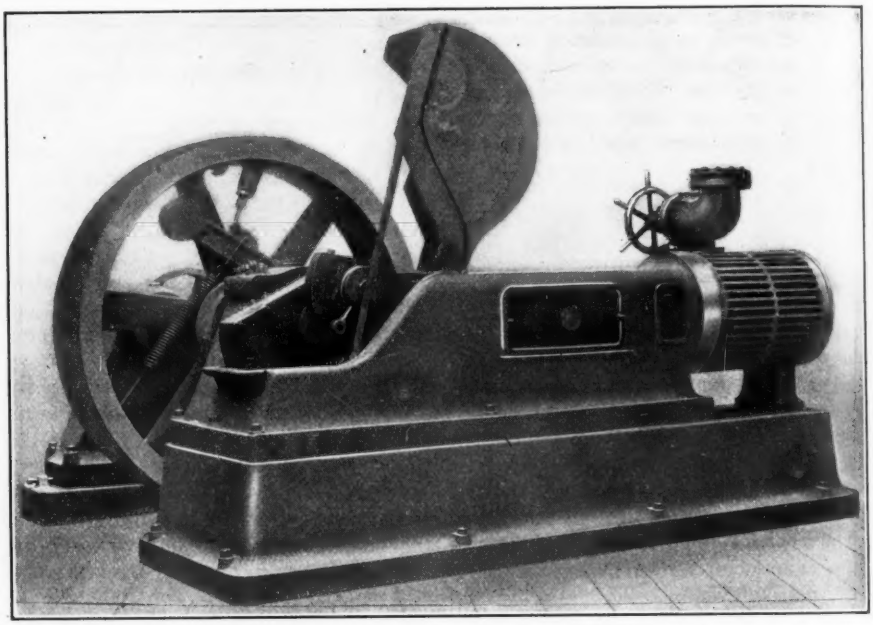


FIG. 1. SHOWING FRAME AND OIL-GUARD CONSTRUCTION

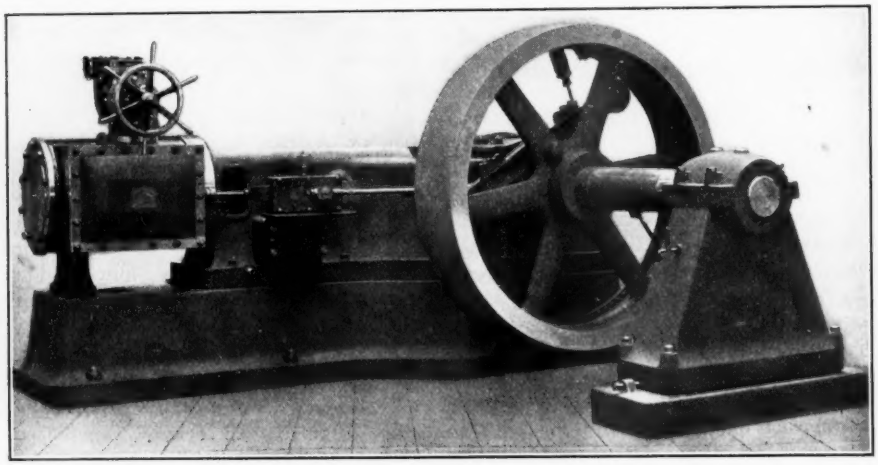


FIG. 2. VALVE-GEAR SIDE

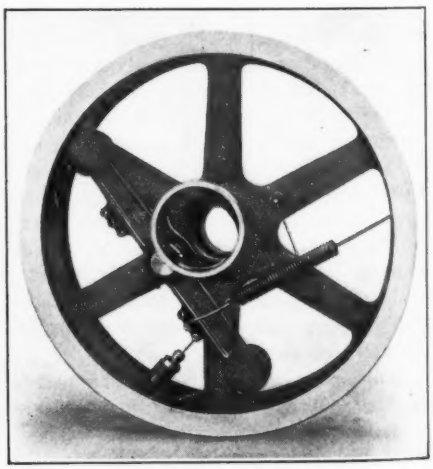


FIG. 3. THE GOVERNOR

a spring on the back. In case of water being carried into the cylinder, both valve and pressure plate lift from the seat and allow the water to pass into the exhaust.

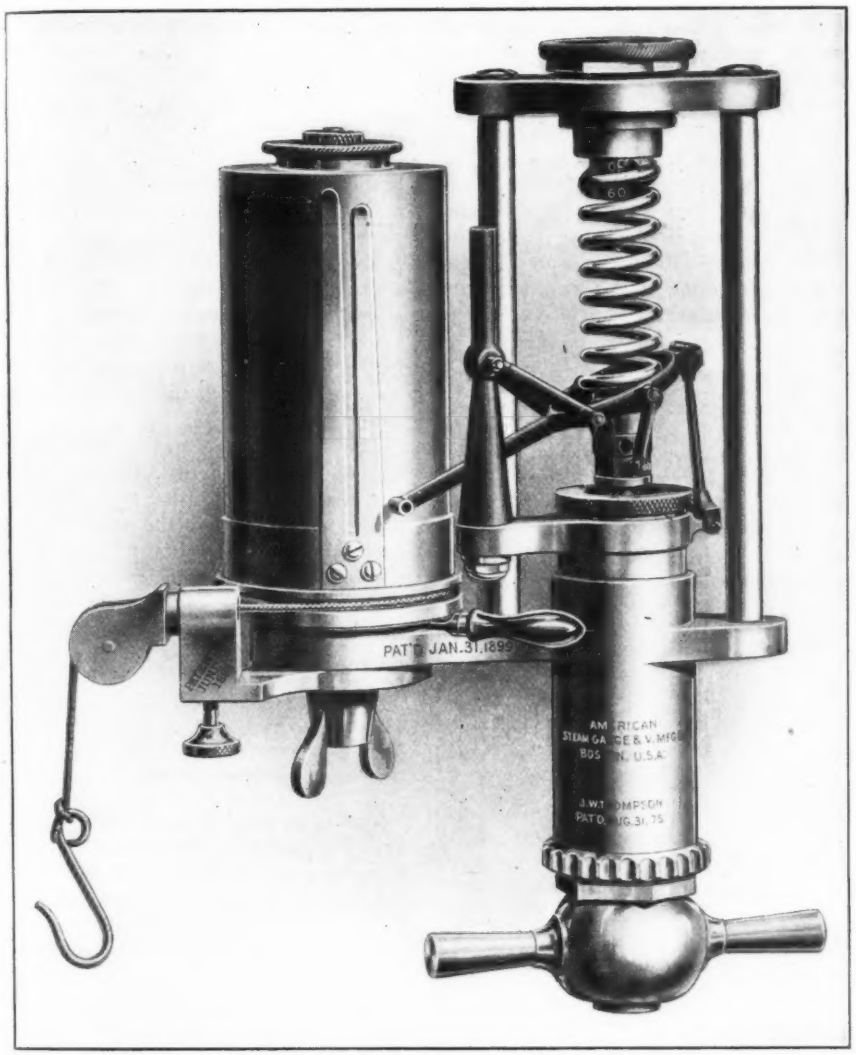
The piston is a single, hollow casting, strongly braced by ribs and made as light as is consistent with strength. It is packed with cast-iron snap rings of especial design. The rod and piston are joined by a force taper fit, supplemented by a jam nut. The rod screws into the crosshead with a long, fine thread and is prevented from turning by a jam nut. This jam nut is further held by a set screw in the crosshead body.

The governor is shown in Fig. 3. It consists of a long inertia bar, having weights at each end, and is pivoted at the center on a roller bearing. To the hub of this bearing is clamped the eccentric, which is keyed in place and is also held by set screws. The eccentric and eccentric strap, being split, may be removed without disturbing the governor or the valve setting. A heavy coil spring is secured to the middle of one end of the bar. Opposite the spring is an oil dashpot, consisting of a cylinder with a loose-fitting piston and a connecting rod bolted to the inertia bar. A bypass with an adjustable opening allows the oil to circulate from one side of the piston to the other.

Two standard methods of lubricating this engine are provided: the "splash system," in which the crank pit is filled with oil, which the disk throws in an almost steady stream over the crosshead and guides, and the gravity system, in which all oil from the bearings flows to the crank pit, from which it is piped to a filter and then passes to a pump chamber, where it is pumped to a large tank on top of the bed. From this tank the oil flows through piping to each bearing. Sight-feed valves are placed in each pipe near the tank so the supply may be shut off or regulated.

This engine is built in the simple, tandem- and cross-compound types. In the compound types the low-pressure valve is of the balanced type, although slightly modified from the one previously described. On tandem engines both valves are driven by the governor, the low-pressure directly and the high-pressure by means of a tail rod on the low-pressure valve. On cross-compound engines the high-pressure valve is driven by the governor and the low-pressure by an eccentric on the main shaft; otherwise the valve gears are identical.

Simple and tandem-compound engines from 50 to 800 horsepower and cross-compound up to 1500 horsepower are manufactured.




AMERICAN OUTSIDE SPRING INDICATOR

## The American Improved Indicator

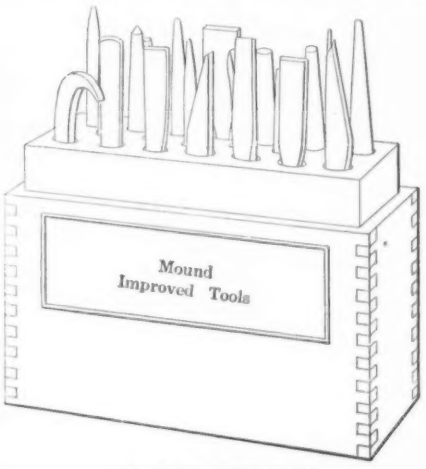
Another outside spring indicator is manufactured by the American Steam Gauge and Manufacturing Company, 208 Camden street, Boston, Mass. The illustration shows its construction, and also that the spring is not in contact with the steam.

The spring remains cool and can be changed without removing the piston or allowing the indicator to cool. It is in line with the piston, and is supported by two standards connected at the top by a cross bar, having a screw for attaching the upper end of the spring. The lower end is connected to the top of the piston. The piston rod and connections are made hollow and as light as possible to prevent error from the inertia of the moving parts.

To remove the spring, unscrew the nurled nut at the top until the end of the spring is released, and turn the spring until it is free from the base. To prevent the piston from turning while removing the spring, insert a steel pin, furnished with the indicator, in holes in the spring base. This instrument is furnished for gas- or steam-engine practice, and can also be furnished with an electric attachment for taking cards from two or more indicators simultaneously.

## Mound Improved Tools

The illustration herewith represents a set of 20 tools for the use of engineers,




SET OF TWENTY TOOLS

electricians, machinists and millwrights, recently put on the market by the Mound Tool and Scraper Company, of St. Louis,

Mo. The tools are conveniently arranged in a finished oak case and each tool is highly polished. The set comprises two cape chisels, three cold chisels, one diamond-point chisel, one round-nose cape chisel, one half-cape chisel, one sheet-metal chisel, one scribe, one bent grooving chisel, one oil-groove scraping tool, one square punch, two rivet punches, one nail set, one prick punch, one center punch, one drift and one round-point flat chisel.

## Flinn Differential Steam Trap

The Flinn differential steam trap is designed to drain the water of condensation from steam pipes and coils, engine cylinders, receivers, jackets and separators, steam kettles, etc. It has neither float nor bucket. It is claimed the trap will handle water at any temperature, and without re-adjustment it works equally well at any pressure below its maximum. It has but three moving parts, the valve, the spring and the diaphragm. The spring, which is adjusted by an outside lever, serves to keep the valve off its seat, and by means of the lever the valve may be held open for emptying the trap or for blowing it out.

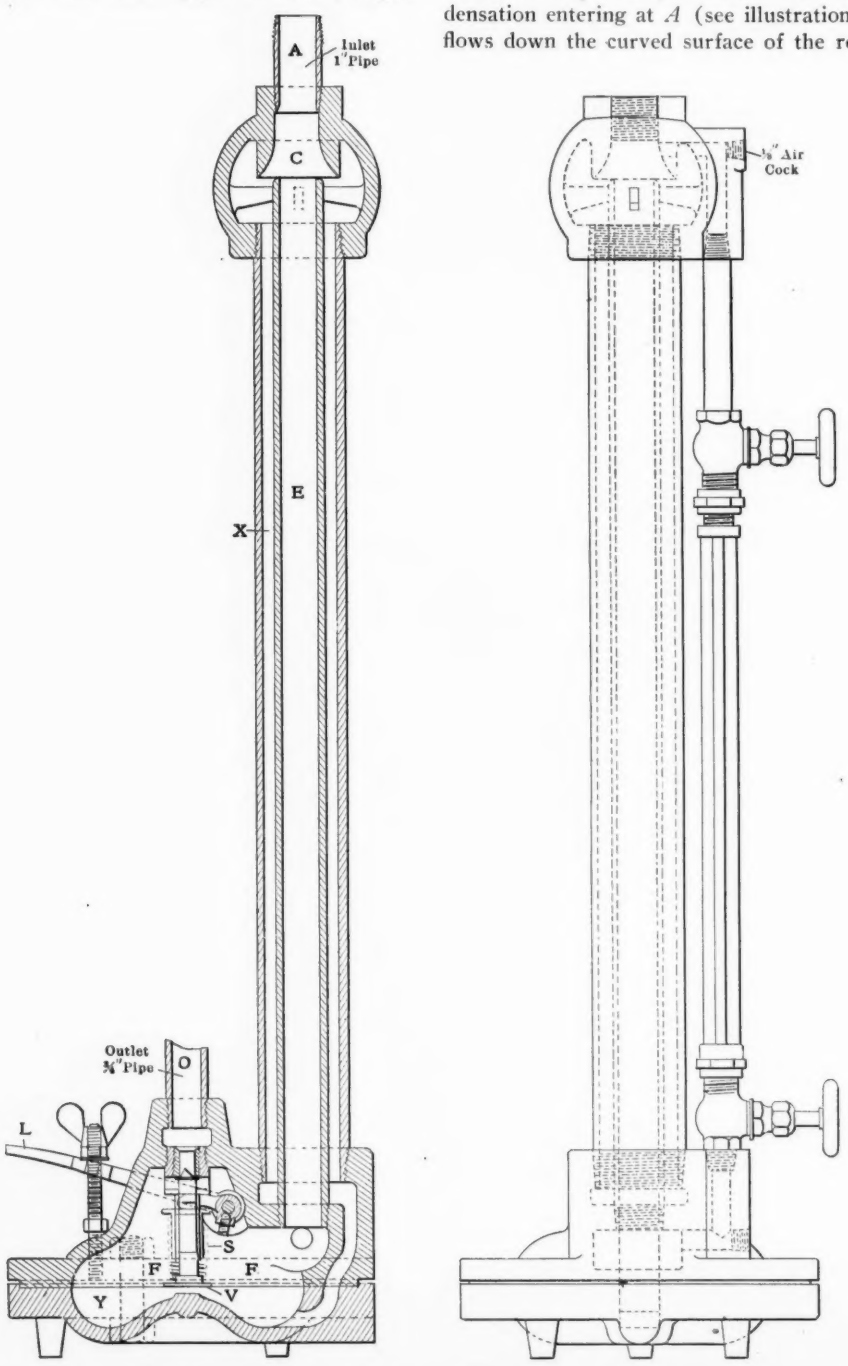
The trap consists principally of two castings of cast iron, two pipes, a bronze valve, a diaphragm of phosphor bronze and a coated steel spring. A gage glass shows the hight of the water in the trap.

When in operation, the water of condensation entering at *A* (see illustration) flows down the curved surface of the receiving chamber *C*, fills the lower chamber *Y*, the pipe *X* and the chamber *C* to the level of the top of the pipe *E*. This column of water acting on the under side of the diaphragm forces the valve *V* to its seat against the counter pressure of the spring *S*. Any additional water that enters the trap overflows the chamber *C* into the pipe *E*, filling the chamber *F F* and pipe *E* to a point about midway of its hight, where the effect of the column of water in the pipe *X* is balanced.

The pressure on each side of the diaphragm is then equal, the shorter column of water in pipe *E*, aided by the spring, balancing the pressure created by the longer column of water in pipe *X*. Farther increase in the hight of the water in pipe *E* causes a depression of the diaphragm, which in turn opens the valve *V*, thus allowing water to escape from the chamber *F F* until the column of water has fallen to a level a little below the middle of the pipe *E*, at which time the valve again closes.

This action is repeated at intervals, according to the quantity of water coming into the trap. The valve acts every time the water rises above the water seal and every time it falls below it. As long as the water enters in sufficient quantity, the valve remains wide open; it is either shut tightly or stands full open to reduce to a minimum the wear due to wire-drawing action.

This trap is manufactured by Richard J. Flinn, West Roxbury, Mass.




SECTIONAL VIEWS OF THE FLINN DIFFERENTIAL STEAM TRAP

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Coal is bought by the ton, dirt included. It is the custom. The custom is absurd. It is not based on common sense. It cannot last. It is gradually being supplanted by the common-sense plan of basing the price on the coal's available steam-raising value. Already in all large power stations the coal is purchased on the basis of its steam-making power and nothing else. The smaller plants get what is left.

The large plants see to it that they get what they pay for and pay only for what they get, and the coalyards simply dump the leavings on the other fellow. They will continue to do so just as long as he lets them, but not a moment longer.

The coal delivered to your works is constantly varying in heat value. No two mines are alike; no two loads are alike, unless in the single matter of their being always black. In fact, it is the commonest of common things for coal to vary 25 to 50 per cent. in steaming efficiency, and this becomes more so every day, as the larger plants deliberately *pick* (because that is just what it amounts to) the best coal from the yards and mines.

It is therefore a serious question how long are you going to allow this to continue in your boiler room, and what steps are you going to take to correct the imposition, because imposition it is of the very baldest kind.

# Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

*Advantage of Two Eccentrics*

What advantage is gained by having two eccentrics on a condensing engine, or on the low-pressure side of a compound-condensing engine?

W. R.

By using two eccentrics the steam and exhaust valves may be set separately, allowing a longer range of cutoff for the steam valves and an earlier opening of the exhaust valves, so the benefit from the condenser may be obtained as quickly as possible.

*Changing Centigrade Degrees to Fahrenheit*

A certain guarantee specifies that the temperature rise in the armature of a generator shall not exceed a given number of degrees Centigrade. Now, how shall I translate degrees Centigrade into degrees Fahrenheit?

F. B.

On the Centigrade thermometer scale the space between the freezing and the boiling point is cut into 100 divisions, while on the Fahrenheit scale there are 180 divisions. Therefore, a Centigrade degree is equal to 180/100, or 9/5 Fahrenheit degrees. But zero on the Centigrade scale is marked at the freezing point, while on the Fahrenheit scale it is 32 degrees below the freezing point. To convert Centigrade readings into Fahrenheit readings multiply the reading on the scale by 9 and divide by 5, then add 32. For instance, 44 degrees Centigrade would be

$$\frac{44 \times 9}{5} + 32 = 111.2.$$

To convert Fahrenheit degrees into Centigrade, the reverse process is followed, subtract 32, then multiply by 5 and divide by 9.

Taking the same example and reversing the operation, we will have

$$\frac{111.2 - 32}{9} \times 5 = 44.$$

*Safe Load on Girder*

Will you please explain how to calculate the safe working load on a girder and supporting column, as per the accompanying sketch?

J. N.

Let $W$ equal the safe load at the center of the girder and $M_r$ the moment of resistance in inch-pounds. Then

$$\frac{W \times 20 \times 12}{4} = M_r.$$

The $M_r$ is calculated as follows: The area of the two 3x3x⅜-inch angles forming the flanges of the girder is 4.22 square inches; the net area of the bottom flange equals

$$4.22 - 0.61 = 3.61$$

square inches (0.61 square inch being the area of two holes for ¾-inch rivets). Assuming that one-sixth of the web plate serves as the flange,

$$1/6 \times 36 \times 3/8 = 2.25$$

square inches, and the total flange area is 5.86 square inches.

The effective depth of the girder is

$$36 - 1.78 = 34.22$$

inches, which equals the distance between the center of gravity of the flange angles.

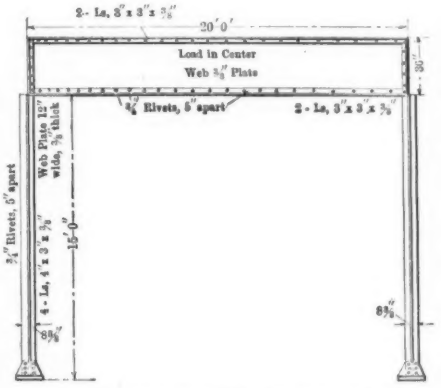
It is good practice to allow a working stress, in the flanges of steel-plate girders, of 14,000 pounds per square inch. Therefore,

$$M_r = 5.86 \times 34.22 \times 14{,}000 = 2{,}807{,}409$$

inch-pounds, and

$$\frac{W \times 20 \times 12}{4} = 2{,}807{,}409,$$

where $W$ equals 46,790 pounds, or approximately 23.4 tons, which is the safe load at the center of the girder, without excessive bending.




GIRDER AND SUPPORTING COLUMNS

The maximum shear on the girder, from this load, equals ½ $W$ = 23,400 pounds. The shear on the web per square inch equals

$$\frac{23{,}400}{36 \times \frac{3}{8}} = \frac{23{,}400}{13.5} = 1733$$

pounds per square inch, which is very safe, as it is good practice to allow 10,000 pounds per square inch on plate-girder webs provided with stiffeners.

The load on each column also equals 23,400 pounds. The area of each column is 14.42 square inches, and the least radius of gyration of the column equals approximately 2 inches; then

$$\frac{l}{r} = \frac{15 \times 12}{2} = 90.$$

It is good practice to allow a stress of 12,000 pounds per square inch on steel columns where the ratio of the unsupported length to the least radius of gyration does not exceed 90. Therefore, the safe load on the column equals

$$14.42 \times 12{,}000 = 173{,}040$$

pounds, which is more than seven times the load on the girder. Therefore, the safe load at the center of the girder is that found by the first calculation and equals 23.4 tons.

# Book Reviews

AMERICAN MACHINIST HANDBOOK AND DICTIONARY OF SHOP TERMS. By Fred H. Colvin and Frank A. Stanley. Hill Publishing Company, 505 Pearl street, New York. Flexible covers, gilt edges; 511 pages, 4x7 inches. Price, $3.

This is a reference book of machine-shop and drawing-room data, methods and definitions. There are many handbooks, but this is the first in which the data required by the purely mechanical man have been assembled. While it is in the main intended for the machinist, there is much material which will interest the steam engineer and power-plant man, as, for example, the sections treating of pipe and pipe threads, gearing, nut and bolt tables, keys and keyseats, belts and shafting, etc. A feature of the book is a dictionary of shop terms, which will not only be of assistance to the beginner, but will tend to a uniform nomenclature of the subject.

THE BOILER. By Stephen Christie. The Christie Publishing Company, Chicago, Ill. Cloth; 264 pages, 6x9 inches; illustrated. Price, $2.50.

The writer of this book has been a boiler maker, both journeyman and master, and a boiler inspector, and has got together in this volume the rules, formulas, tables, data, etc., which have proved useful to him in those capacities. He makes no claim to originality and much of it will be found in other forms, but he has presented it in a way which will be attractive to the man of limited mathematical abilities, working all the examples out in ordinary arithmetic. The author has imbibed a healthy regard for his vocation. "Boiler designing," he says, "is a science and much depends upon the accuracy of details." "Boiler construction can be classed as one of the highest among crafts." The subject of Material is disposed of in the first 17 pages. The second chapter, upon the Selection of the Boiler, treats of heating surface per horsepower, engine horsepower, mensuration of plain services and of solids, tables of areas, decimals of feet and inches, horsepower measurement, properties of steam, engine notes and thermometry. Succeeding chapters follow more closely the lines indicated by their titles and treat of Boiler Construction, Braces and Reinforcing, excerpts from the Government Rules, Lap Joints, Butt Joints, Safe Working Pressure, Tests and Inspections, and Miscellaneous.

## Tension on Bolts Due to Screwing Up

By William F. Fischer

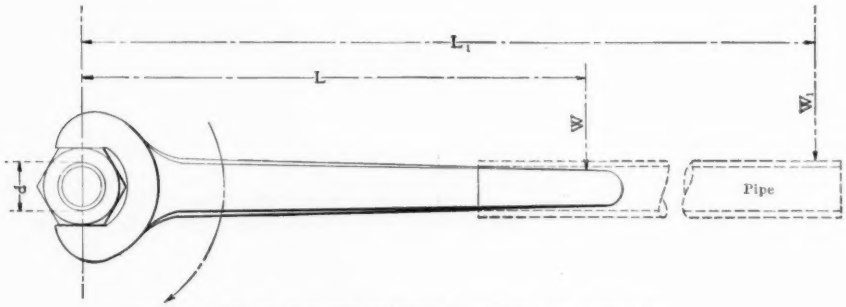
The question is very often asked: To what extent is a bolt strained when tightening up a joint in pipework, cylinders, etc? In practice, the strain put on a bolt by a workman varies greatly, as no two men will often exert the same force at the end of a wrench. If this force were known the strain could be figured out quite accurately in each case. Professor Unwin, in his "Elements of Machine Design," gives the following equation, which takes into account the screw thread and nut friction for triangular threads, where the flange is spot faced or finished on the back to insure a smooth surface for the nut to turn on:

$$W\,L = 0.17\,d\,T, \qquad (1)$$

where

$W$ = Pull in pounds exerted on the end of the wrench by the workman,

$L$ = Length in inches from center of bolt to point of applied force,




TENSION ON BOLT DEPENDENT ON LEVERAGE OF WRENCH

$d$ = Diameter of bolt outside of threads,

$T$ = Tension in bolt in pounds due to screwing up.

Then $W\,L$ equals the twisting moment in inch-pounds, which is resisted by $0.17\,d\,T$. The second term of the equation $0.17\,d\,T$ was derived from experiment on different-sized bolts, and an average taken to suit all practical purposes, as follows:

Average moment to overcome thread friction equals $0.084\,d\,T$.

Average moment to overcome friction f nut on its bearing (the part of the flange the nut bears on is assumed to be spot faced, or finished) equals $0.087\,d\,T$.

Then $0.084\,d\,T + 0.087\,d\,T$ equals $0.17\,d\,T$, which equals the average total moment to overcome friction in tightening up the bolt.

Referring to Fig. 1, Mr. Unwin assumes the average pull of a workman to be 40 pounds applied at $W$, and the length $L$, as usually made for spanner wrenches, equals sixteen times the bolt diameter. Then by transposing in equation (1), we get

$$T = \frac{W\,L}{0.17\,d}, \qquad (2)$$

and by substituting 40 pounds for $W$, and 16 $d$ for $L$, the equation becomes,

$$T = \frac{40 \times 16\,d}{0.17\,d},$$

and by cancelling $d$,

$$T = \frac{40 \times 16}{0.17} = 3765$$

pounds, which equals the tension in any size of bolt due to screwing up. This is given as a fair average.

Now in the case of a leaky joint, where a joint made up by a gasket leaks under pressure, a man will not usually hesitate to put a piece of pipe over the end of the wrench, as shown in the illustration, to increase the leverage, and he is very apt also to exert a greater force at the end of it than 40 pounds, this force being applied, say, at $W_1$. This makes equation (1) read as follows:

$$W_1\,L_1 = 0.17\,d\,T \qquad (3)$$

or

$$T = \frac{W_1\,L_1}{0.17\,d}, \qquad (4)$$

where

$W_1$ = Pull exerted by workman in pounds,

$L_1$ = Length in inches from the center of the bolt to the point of force applied on wrench,

$d$ = Diameter of bolt over threads,

$T$ = Tension on bolt, in pounds, due to screwing up.

Assume the following case of a leaky joint where the fitter slips a piece of pipe over the end of his spanner wrench, making the distance $L_1$ equal to 40 inches. Take the diameter of the bolt to be 1½ inches, and say that a pull at $W_1$ of 60 pounds is exerted. Then by substituting these values in equation (4),

$$T = \frac{60 \times 40}{0.17 \times 1.5} = 9412$$

pounds.

A careful workman will know from his experience just about how much force to safely apply to the wrench, when tightening up bolts, but it is a good point in designing never to use a bolt under ¾ inch in diameter for rough work, if it can be helped, for bolts smaller than this are very easily crippled in tightening up. Not knowing who is going to pull on the end of the wrench, but little more is known now than before regarding the amount of strain put on a bolt in screwing up, for it would seem that $T$ can be assumed to equal almost anything within reason.

## A Novel View of Thermodynamics

Dr. Charles P. Steinmetz has just concluded a series of interesting lectures before the Schenectady section of the American Institute of Electrical Engineers, on "Thermodynamics." In the first lecture, Dr. Steinmetz described how all heat phenomena can be explained by assuming heat energy to be that of irregular molecular motion, and presented an interesting hypothesis to the effect that the molecular motion in solids is elliptical up to the boiling point, when it becomes parabolic; when the substance is reduced by heat to a gaseous condition, the molecular motion becomes hyperbolic.

From the law of gravitation and the foregoing hypothesis, and by the aid of much mathematical travail, the doctor reached the accepted formulas

$$p\,v = R\,T$$

and

$$p\,v^n = Constant,$$

which constitute the fundamental equations of the thermodynamics of gases. The first equation, he explained in the second lecture, does not apply unless the molecular orbits are strongly hyperbolic—that is, the medium is strictly gaseous. From the relations, derived mathematically, between the molecular, intramolecular, "position" and external energies, the lecturer deduced a rather unwieldy three-term expression for the equivalent of $p\,v$ for dry steam, and then pointed out that except for the single purpose of computing the temperature of steam from the pressure and volume, the formula was not necessary, a much more manageable one being

$$p_0\,v_0^{\,e} = Constant.$$

For the value of $e$ he gave 1.064; the pressure $p_0$ is that at which the steam reaches saturation when following the adiabatic curve.

The remainder of the second lecture followed along the lines of Dr. Steinmetz' paper read before the American Society of Mechanical Engineers and abstracted in Power and The Engineer for March 17, 1908. This lecture also dealt with the characteristics of superheated steam passing through a turbine and with the proportions of expansion nozzles for such turbines based on the behavior of the steam. The final lecture was devoted to the application to the steam turbine of the equations derived in the preceding lectures. This is not susceptible of being abstracted or explained except mathematically.

The most interesting feature of the lectures was Dr. Steinmetz' fundamental assumptions as to heat energy, which are so heterodox as to provoke speculation on the possibility of their having been developed by "figuring backward" and the lively exercise of imagination.

## Location and Care of Fusible Plugs

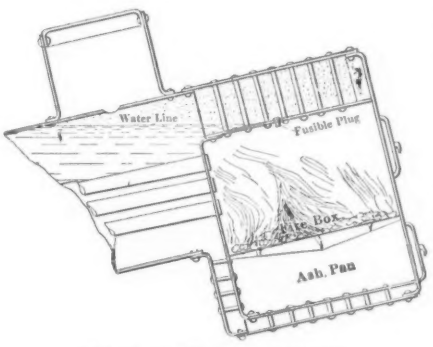
By E. T. Binns

Among safety devices for steam boilers the fusible plug is far from being the least important. Like all other adjuncts of its class it is only to be depended upon when given reasonable care. It should be removed and examined frequently, as the filling may become covered with scale. If allowed to remain in the boiler any great length of time the composition of the alloy is likely to change, and the plug will become unreliable. The United States inspection law requires at least one fusible plug in every marine boiler, with the exception of water-tube boilers, the plug to be made of a bronze casting filled with Banca tin from end to end. I maintain that too much emphasis cannot be placed upon the importance of the care of fusible plugs, believing that many boiler failures would never have been chronicled had more care been given to this feature. The attendant may be addicted to carelessness, having often had low water with no apparent bad results, but let the plug blow out and the whole force will know about it; for the boiler must of necessity be cooled to replace the plug.

Instances are not rare of plugs being filled with solid metal, or replaced with a solid gas plug to prevent the bother attendant upon the blowing out of the alloy. An interesting circumstance in this connection happened several years ago. The boiler was that of a traction engine. We had occasion to go down a steep hill. The fire box was at the rear end and the fusible plug in the crown sheet over the furnace. The water was run up with the hope of keeping all parts of the heating surface submerged. Upon a trial of the hill, it was found necessary to work some steam against the piston and the water came over into the cylinder of the engine. Nothing would do then but to blow down. This done, we proceeded a short distance with all the water in the front end of the boiler, when, true to its purpose, the plug blew out and we had to draw the fire and cool the boiler sufficiently to renew the plug temporarily with a solid one. Steam was got up and the engine was turned around and backed down the hill. This kept the water over the crown sheet without carrying it high enough to go over into the cylinder.

The best location for the fusible plug in a return-tubular stationary boiler is in the rear head, 2 or 3 inches above the top row of tubes. In internally-fired boilers a plug which extends a couple of inches above the crown sheet is all right, as the melting out of the plug may prove a temporary stimulus to the fire, particularly where the emission from the boiler to the fire box is mostly steam, not very great in amount. The increased draft may have a tendency to brighten the fire and intensify the heat. If the attendant has warning, however, before the plates are entirely uncovered, he may deaden his fire before any injury is done.

The writer has always believed it good practice, upon taking charge of old boilers, to examine the fusible plugs to see if they really were what they pretended to be. The filling in the plugs should be changed at least once every six months. Usually, however, the price is so inconsiderable that a quantity already fitted may be kept on hand. A liberal supply




BOILER OF TRACTION ENGINE

of graphite should be used upon the threads before screwing them into the plate. Oil should not be used, as this is likely to become carburized.

## No. 14's Annual Ball

The annual ball of the National Association of Stationary Engineers, under the auspices of No. 14, of Roxbury, Mass., was held in Paul Revere hall, Mechanics' building, Boston, Wednesday evening, November 25. The large attendance and the good time enjoyed by all present speaks well for the fitness of the committee chosen to conduct the affair. Many State and national officers were present.

Saturday eveping, November 28, F. L. Johnson delivered a lecture on condensers and air pumps to the engineers of New Bedford, Mass. The lecture was illustrated by lantern slides and the blackboard was also used.

Past National President P. H. Hogan spoke to the National Association of Stationary Engineers and their friends in Fall River, Mass., on the subject of feedwater treatment, on Saturday evening, November 25.

## Curing an Oil Pump Trouble

By F. L. Johnson

The chief was passing through the engine room one day when his attention was called to a little matter that needed the services of a machinist. Not finding the machinist in the shop, he hunted until he found him in another department packing the piston of an oil pump with the usual form of tuck packing. Inquiry elicited the information that two weeks was the average life of this style of packing when used in the cylinder of an oil pump. This installation was in duplicate and the chief said to the machinist:

"When you have that pump in good running order disconnect the other and take it over to the machine shop. This is the third time within a month, when I have wanted you, that I have been told that you were at work on the oil pumps. I think it about time to fix these pumps so that they will not need fixing every few days."

The pump was taken to the shop, the regulation piston taken off the rod, and a solid cast-iron piston with four narrow spring piston rods substituted. Sundry other little changes were made, such as changing the taper fit of the pistons to a straight one, permitting of easy removal when occasion required. The pump was put in first-class working order and returned to its place in the oil line. Its mate was attended to in the same manner within a very few days.

"There," said the chief, when the second pump was being put into service, "I do not think you will be bothered with having to pack either of those pump pistons for years."

He was right. For seven years those pumps worked alternate weeks, twenty-four hours a day, and never needed the attention of a mechanic. They are still running and to all appearances another seven years of service will not impair their usefulness.

## An Enjoyable "Smoker"

A "smoker" entertainment was held by Seth Boyden Association No. 7, N. A. S. E., of Newark, N. J., on Wednesday evening, November 25. There was a larger number present than was expected, and although the hall was somewhat crowded, the committee succeeded in making everybody happy. During the evening speeches were made by W. J. Reynolds, national vice-president of the N. A. S. E.; J. J. Calahan, John Foote, of the McLeod-Henry Company, and others. The entertainers were Frank Martin and William Murray, of Jenkins Brothers; John Walker and Jack Armour. This association, though small at present, is rapidly increasing in membership.

## Modern Science Club

Tuesday, November 24, C. J. Simeon delivered a lecture before the Modern Science Club, of Brooklyn, on "Automatic Scales in Modern Industries." The lecturer spoke of the difficulty of educating the public to accept automatic machine weighing in place of the usual personally conducted operation. This opposition was first met and overcome in England, where the Avery scale was first introduced. In all large commercial enterprises where the weight of material enters in any form, automatic weighing is universal.

That part of the lecture most interesting to the operating engineer was the description and illustrations of the apparatus as used in the boiler rooms for recording the weights and delivering the coal to separate boilers. This is preferably an overhead arrangement with a fixed scale for each boiler or scales running on overhead tracks from points of supply to individual boilers.

Another type was a scale truck running either on a track or the floor. The first type is made to weigh a fixed quantity each time, while with the second the amount weighed will be whatever is put on the truck whether it be much or little.

## A Quick Shipment and Installation

On October 28 an accident occurred in the municipal lighting plant of Frankfort, Ind., by which the engine and generator being operated there were wrecked, necessitating the immediate installation of a new unit. On the following morning, in response to a telegram, a sales engineer attached to the Chicago office of Allis-Chalmers Company was on the ground and had submitted proposal for a steam turbine and generator of 500 kilowatts capacity to operate at 3600 revolutions per minute and deliver two-phase 60-cycle current at a terminal pressure of 2300 volts. The contract for this unit, which was signed at a late hour that same day, specified shipment of the unit within six days from such hour, and the contract was at once taken to the West Allis works of the Allis-Chalmers Company, near Milwaukee, being delivered there at 2:30 p.m. on October 30. For the steam end of this unit a turbine then nearly complete in the shop was selected, and the finishing work upon it rushed. There was, however, no turbo-generator available designed for the frequency, phase and voltage required; hence one had to be entirely wound. Notwithstanding this fact, however, the generating unit complete in every detail was shipped by express at 11 o'clock, November 3, in a special automobile car, and arrived in Frankfort at 3 o'clock the following morning. Four days later the unit had been completely installed and connected to its auxiliaries. During that day the generator coils were baked out, as is necessary to be done in all cases before a machine can be started, and on the following morning, November 8, the unit was in regular operation and carrying the station load, precisely thirteen days from the time the original engine had been wrecked.

## Business Items

The Wagner & Wilson Mill Company, of Monroe, Wash., has given an order to the Minneapolis Steel and Machinery Company for one 18x36" Twin City Corliss engine for the new sawmill now being built at Monroe.

The Henry Steam Flue Cleaner Company, Ashland, Wis., has received a letter from J. H. Beach, secretary and treasurer of the Iowa Steam Laundry, of Ottumwa, Iowa, in which he says: "The cleaner is doing fine work."

Grant W. Spear, for many years connected with the Dearborn Drug and Chemical Works, and for the past seven years one of the vice-presidents, in charge of offices from Pittsburg to Denver, with headquarters in Chicago, has recently been transferred to New York as Vice-president and manager, with headquarters at 299 Broadway.

Barbour & Starr, Toledo, Ohio, in writing to the Buckeye Boiler Skimmer Company, said: "Since installing the Buckeye automatic boiler skimmers we find all impurities are removed from water in boilers, preventing formation of scale, foaming and saving cost of repairs, fuel and time and expense of cleaning."

The Walter L. Flower Steam Specialty Company, St. Louis, Mo., reports some recent good orders and a general improvement in business. The company has just shipped six oil filters to the Vacuum Oil Company for use in Kobe and Yokohama, Japan; two to the Valveoline Oil Company, Los Angeles, Cal., and two to the New York Life Insurance Company for its buildings in St. Paul and Kansas City.

The Liberty Compound Company, manufacturers of marine and stationary boiler compounds, has been reorganized, and is conducting its business on a more extensive scale than ever before. The company is doing all kinds of analytical work and making a specialty of the treatment of boiler feed waters. Arthur J. Arwine, who is well known in New York engineering circles is at the head of the company, whose main offices are at 90 West street, New York.

Another large textile mill is being equipped with electric drive by the engineers of the Crocker-Wheeler Company, manufacturer of electrical machinery, of Ampere, N. J. A complete electric power plant, including motors, transformers and switchboards, has just been shipped by that company to the Windham Manufacturing Company, of Willimantic, Conn. The equipment consists of nine 550-volt squirrel-cage induction motors aggregating about 500 horsepower, which will be used to drive the machinery in the mill. The generating equipment consists of two 500-kilovolt-ampere, 600 revolutions-per-minute generators. The current will be generated at 600 volts, 60 cycles, 3-phase, and will be transformed to 110 volts for lighting. The motors are all arranged for ceiling suspension. The transformers for the lighting system and the switchboard were also furnished by the Crocker-Wheeler Company.

## New Equipment

The Yolande Coal and Coke Company, Birmingham, Ala., is preparing plans for the construction of a power plant.

E. B. Hill, Alvin, Texas, has been granted a franchise by the city council to erect and operate an electric-light plant.

The Town Board, Mulberry, Ind., is said to have under consideration the question of constructing an electric-light plant.

The city of Newport, Ky., has voted $100,000 bonds for improvements to water works. W. L. Glazier, superintendent water works.

The Monett (Mo.) Electric Light, Power and Ice Company will establish a day service, which will involve an expenditure of about $7,000

The Clarksville (Ga.) Railway Company has been incorporated to establish an electric street railway system. E. S. Hunnicutt and Robt. McMillan, incorporators.

The Pittsburg (Penn.) Manufacturers' Power Company is being formed by Frank J. Kleber, W. J. Stewart and Albert Martin for the purpose of building and operating a power plant.

The Panhandle Electric Company, New Cumberland, W. Va., has been organized with a capital of $50,000. A. S. Cooper, of New Cumberland, is one of the incorporators.

The city of New Albany, Miss., has issued $10,000 bonds, proceeds to be used to purchase additional equipment for the municipal electric-light plant. G. S. Mitchell, clerk.

The citizens of Seneca, S. C., have voted to issue $25,000 bonds for the construction of an electric-light plant and water works. Dr. W. F. Austin is chairman public works.

The Washington Water Power Company, Seattle, Wash., contemplates improvements to cost about $16,000,000, at the rate of $2,000,000 a year. The capital stock of the company has been increased.

The Russellville (Ark.) Light and Water Company, which is a reorganization of the Russellville Ozark Mountain Light and Traction Company, proposes to construct a $100,000 light and water plant.

The Lewisburg (Tenn.) Light and Power Company will purchase the municipal electric-light plant and will make improvements, including the installation of an ice-making and cold-storage plant.

The La Crosse (Wis.) Water Power and Electric Company is being formed to erect a water-power plant, at a cost of about $250,000. William Neumeister and N. Haskell Withee are interested.

The Evansville (Ind.) Gas and Electric Light Company is planning improvements which involve an expenditure of about $400,000. These include the installation of a new turbo generator set.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., December 14 for two water-tube boilers, surface condenser, generator and engine, gaskets, etc., as per circular No. 481.

Bids will be received by the Isthmian Canal Commission, Washington, D. C., up to 10:30 a.m. December 21 for seven marine boilers, pipe fittings, valves, cocks, steam gages, gage glasses, etc., as per Circular No. 482.

Bids will be received until 4 p.m. December 16 by the board of managers, Agnew State Hospital, Agnew, Cal., for boiler room equipment, engines, generators, switchboard, etc. Sellon & Hemmings, San Francisco, state architects.

The Fresno, Hanford and Summit Lake Interurban Railway Company will build an electric railway from Fresno to Hanford. Main power station will be at Kingsburg

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Montreal, 444 St. James Street.
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with substations at Malaga and Laton, L. A. Nares, Fresno, Cal., president.

An appropriation of $200,000 has been made for improving the plant of the Lackawanna Valley Electric Light and Power Company, at Scranton, Penn., which was recently acquired by the American Gas and Electric Company. G. N. Tidd is general manager.

The United Utilities Company, Barboursville, W. Va., has been organized for the purpose of building and operating a combined electric, water, ice, telephone and steam-heating plant. The following equipment is wanted: One 25-kilowatt, 225-volt direct-current generating set, one 50-gallon per minute turbine pump (vertical preferred) direct connected to a vertical motor of 220 volts. This pump to operate against a head of about 300 feet through about 1500 feet of 3-inch pipe. Two 50-horsepower boilers (vertical preferred) to operate at 125 pounds. A three-panel switchboard for two 225-volt generators to operate in parallel on six 50-ampere light and power circuits. One two-ton ice plant complete, delivered and erected, and operated for not less than a week by the contractor. In addition there will also be required a lot of pipe, fittings, valves, heaters, traps, etc. L. L. Dowthat is manager.

## New Catalogs

Pratt & Whitney Company, Hartford, Conn. Catalog. Milling machines, die sinkers, profilers. Illustrated, 40 pages, 9x12 inches.

The Henry Steam Flue Cleaner Company, Ashland, Wis. Catalog. Henry steam flue cleaner. Illustrated, 8 pages, 3½x5½ inches.

Harbison-Walker Refractories Company, Pittsburg, Penn. Booklet. "What Are Your Lime Kiln Costs?" Illustrated, 18 pages, 6x8½ inches.

Jordan Brothers, Incorporated, 74 Beekman street, New York. Catalog. Jordan commutator truing device. Illustrated, 32 pages, 4½x7 inches.

American Boiler Economy Company, North American building, Philadelphia, Penn. Catalog. Copes boiler feed regulator. Illustrated, 32 pages, 6x9 inches.

Victor R. Browning & Co., Cleveland, Ohio. Bulletin No. 2. Overhead electric traveling cranes. Illustrated, 8 pages, 6x9 inches. Bulletin No. 3. Type A Armington Hoist. Illustrated, 4 pages, 6x9 inches.

The Crocker-Wheeler Company, Ampere, N. J. Bulletin No. 106. Direct-current switchboard panels. Illustrated, 20 pages, 7½x10 inches. Bulletin No. 107. Direct-current lighting and power generators. Illustrated, 16 pages, 7½x10 inches. Bulletin No. 108. Engine type alternating-current generators. Illustrated, 12 pages, 7½x10 inches. Bulletin No. 109. Generating sets. Illustrated, 4 pages, 7½x10 inches.

The Geo. F. Blake Manufacturing Company, 115 Broadway, New York. Bulletin No. B-815. Blake boiler feed and tank pumps. Illustrated, 20 pages, 6x9 inches. Bulletin No. B-817. Blake vertical high-speed engines. Illustrated, 4 pages, 6x9 inches. Bulletin No. K-813. Knowles mine sinking pumps. Illustrated, 8 pages, 6x9 inches. Bulletin No. K-814. Knowles boiler feed and tank pumps. Illustrated, 20 pages, 6x9 inches. Bulletin No. K-818. Knowles single horizontal piston pumps.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

SALESMEN WANTED to sell a high-grade steam specialty. Must be competent. Address P. O. Box 467, Altoona, Pa.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Corliss engine designer for water works service. Must be familiar with every detail of same. State experience and pay expected. Box 68, POWER.

WANTED—By prominent engineering house on the North Pacific coast, a practical mechanical draftsman. One acquainted with power plant design preferred. Splendid opening for one who is in earnest. Address, giving full particulars as to qualifications, salary wanted, etc. Box 65, POWER.

AGENTS to sell one of the best known and widely advertised shaking grates on the market. Exclusive territory granted to anyone who can make good. Liberal commission. Perfection Grate Co., Box 1081, Springfield, Mass.

AGENTS WANTED for the United States, Canada, Mexico, Cuba, South America. Large continental sheet packing manufacturers wish to appoint representatives for their famous jointing sheet. Firms interested in the above proposition please address "Europe," POWER.

## Situations Wanted

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SITUATION WANTED as salesman; six years' power plant experience by technical graduate; 28 years old. Address "A. J.," POWER.

CHIEF ENGINEER having 20 years' experience with modern engines, boilers and a.c. and d.c. generators, desires position. Can give references and good economy. Box 61, POWER.

SALESMAN to sell anything in the engineering line. Twenty-eight years' experience; fourteen on the lakes as chief engineer, and fourteen in stationary plants. Well acquainted in Chicago among business men and engineers. Jas. A. Macauley, 4622 Calumet Ave., Chicago. Credentials on application.

POSITION WANTED—The master mechanic of a large factory, who has brought out several labor-saving devices for present employers, wishes to secure a position affording broader scope for similar work. Well posted on steam, electric, air and general factory machinery, millwrighting and construction work. Box 69, POWER.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Set of books furnished by I. C. S. with stationary engineers course. Address Box 186, Bound Brook, N. J.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner, U. S. Patent Office, McGill Bldg., Washington, D. C.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

FOR SALE—30 H.P. suction gas producer. Now in daily operation; in use eight months. Termaat & Monahan Co., Oskosh, Wis.

Queen Acme portable testing set with leather case; perfect condition: $50. V. R. Hughes, 228 Majestic Bldg., Denver, Colo.

FOR SALE—Direct-connected engine and generator. 100 kw.; direct current; good as new. Address Monarch Machine Works, Altoona, Pa.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—20"x42" improved Greene engine. Wheel 32"x14'. Used seven years. Also 24"x48" improved Greene engine. Wheel 42"x16'. Used eight years. Both engines in first class shape. Can be seen running. The Capewell Horse Nail Co., Hartford, Conn.

19x20 Chuse automatic engine, direct connected to two 100 kw. Bullock, 125 volt, d.c. generators. 7¼x13x14 Lake Erie vertical cross-compound engine, direct connected to two 25 kw. General Electric 125 volt, d.c. generators. S. H. Supply Co., Denver, Colo.

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# COCHRANE SEPARATORS

## WHERE TO USE AN OIL SEPARATOR

The value of exhaust steam depends on getting the oil out of it. Exhaust steam purified of oil is just as good for heating, drying, exhaust steam turbines or absorption ice machines, as is live steam at the same temperature, and the exhaust steam contains from 80 to 90% as much heat as was originally put into the live steam.

Oil is a detriment, even in the most simple and ordinary uses of exhaust steam. Take steam radiators for instance. If you allow oil to enter them, it will in time so coat the inner surfaces as to reduce greatly their heat transmitting efficiency; not only that, but the oil will then come through in the condensed water or returns, and you will have to throw the returns away, although otherwise, they would be unequaled for boiler feeding.

Again, when exhaust steam is sent into a closed heater, the oil accumulates on the pipes, and, with oil on one side and scale on the other, the heater in time becomes practically useless. The same thing applies to drying rolls or calendars, drying coils, hot blast heaters, etc.

In the case of exhaust turbines, you want a separator not only to take out the oil, but also to remove the water and moisture, since water is highly destructive to turbine blades. Besides, if you allow the oil to reach the condenser, it will injure the efficiency of the latter and prevent obtaining the high vacuum indispensable to high turbine efficiency, besides spoiling the condensation as boiler feed.

With an absorption ice machine, you want the oil out so that you can afterwards use the condensed steam for ice-making.

There is no question, therefore, but that oil should always be removed thoroughly from exhaust steam, but, you say, what separator will do it? Our answer is, Cochrane Oil Separators are now satisfactorily protecting over 8,000,000 H.P. of boilers from oil and we guarantee them to deliver exhaust steam so thoroughly purified from grease or cylinder oil that water heated by actual contact with this steam will be entirely suitable for boiler feeding, and for use in dye-houses, laundries and ice plants and for other purposes, and that this steam when condensed will be equally suitable for similar uses.

We would be pleased to help you on any exhaust steam problem that you may have.

HARRISON SAFETY BOILER WORKS,

17TH. & CLEARFIELD STS., PHILADELPHIA, PA.

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McGowan Co., John H., Cincinnati, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Union Steam Pump Co., Battle Creek, Mich.
Westinghouse Traction Brake Co., Pittsburg, Pa.
Wisconsin Engine Co., Corliss, Wis.
York Mfg. Co., York, Pa.

**Alarms, Water**

Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.

**Alcohol Distillery Apparatus**

Continental Natural Gas Alcohol Co., Wheeling, W. Va.

**Arch, Back Combustion Chamber**

McLeod & Henry Co., Troy, N. Y.
Mayville Specialty Mfg. Co, Mayville, Wis.

**Arch, Boiler**

McLeod & Henry Co., Troy, N. Y.

**Arch, Boiler Door**

Mayville Specialty Mfg. Co., Mayville, Wis
McLeod & Henry Co., Troy, N. Y.

**Asbestos Goods**

Carey Co., Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.
Restein Co., Clement, Philadelphia, Pa.

**Bars, Cylinder Boring**

Underwood & Co., H. B., Phila., Pa.

**Batteries, Storage**

Westinghouse Machine Co., Pittsburg, Pa.

**Belt Fasteners**

Bristol Company, Waterbury, Conn.

**Belting, Leather**

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
N. Y. Belting & Packing Co., New York.

**Belting, Leather** —*Continued.*

Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robins New Conveyor Co., New York.
Sawyer Belting Co., New York.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

**Benders, Hydraulic**

Watson-Stillman Co., New York.

**Bending, Pipe**

Harrisburg Pipe & Pipe Bending Co., Harrisburg, Pa.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

**Bends, Pipe**

Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

**Blocks, Chain**

Yale & Towne Mfg. Co., New York.

**Blowers**

Beggs & Co., James, New York
De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
McClave-Brooks Co., Scranton, Pa.
Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

**Blowers, Furnace**

McClave-Brooks Co., Scranton, Pa.

**Boilers**

Babcock & Wilcox Co., New York.
Beggs & Co., James, New York.
Edge Moor Iron Co., Edge Moor, Del.
Griffith & Wedge Co., Zanesville, O.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler & Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.

**Boilers**—*Continued.*

Morrin Climax Boiler Co., Brooklyn, N. Y.
Oil Well Supply Co., Oswego, N. Y.
Parker Boiler Co., Philadelphia, Pa.
Phoenix Iron Works Co., Meadville, Pa.
Robb-Mumford Boiler Co., South Framingham, Mass.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machinery Co., Henry, Louisville, Ky.
Wetherill & Co., Robert, Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

**Boilers, Second Hand**

Wickes Boiler Co., Saginaw, Mich.

**Books**

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.
System Co., Chicago, Ill.

**Boosters**

Ridgway Dynamo & Engine Co., Ridgway, Pa.

**Brick, Fire**

C-O-Two Furnace Co., Syracuse, N. Y.
McLeod & Henry Co., Troy, N. Y.

**Building Materials, Fireproof**

Carey Co., Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

**Castings, Brass and Iron**

Homestead Valve Mfg. Co., Pittsburg, Pa.
McClave-Brooks Co., Scranton, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

**Castings, General**

Neemes Bros., Troy, N. Y.

**Castings, Malleable**

Jeffrey Mfg. Co., Columbus, O.

**Cement, Asbestos**

Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., New York.

**Cement, Boiler**

Smooth-On Mfg. Co., Jersey City, N. J.

**Chimneys**

Wiederholdt Construction Co., Chicago, Ill.

**Chimneys, Reinforced Concrete**

Wiederholdt Construction Co., Chicago, Ill.

**Clamp, Steam Joint**

McCrea & Co., James, Chicago, Ill.

**Clamp, Pipe**

McCrea & Co., James, Chicago, Ill.
Simplex Engineering Co., Philadelphia, Pa.

**Cleaners, Mechanical**

Lagonda Mfg. Co., Springfield, Ohio.

**Cleaners, Tube**

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Chesterton Co., A. W., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.
General Specialty Co., Buffalo, N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
McCrea & Co., James, Chicago, Ill.
Pierce Co., Wm. B., Buffalo, N. Y.
Robertson & Sons, Jas. L., New York.
Stewart Heater Co., Buffalo, N. Y.

**Cleaners, Steam Flue**

Henry Steam Flue Cleaner Co., Ashland, Wis.

**Cleaners, Turbine Boiler Tube**

Lagonda Mfg. Co., Springfield, Ohio.

**Clocks**

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Standard Gauge Mfg. Co., Foxboro, Mass.

**Clutches, Friction**

Reeves Pulley Co., Columbus, Ind.
Williams Fdry. & Mach. Co, Akron, Ohio.

**Cocks, Air**

Williams Valve Co., D. T., Cincinnati, Ohio.

**Cocks, Blow-Off**

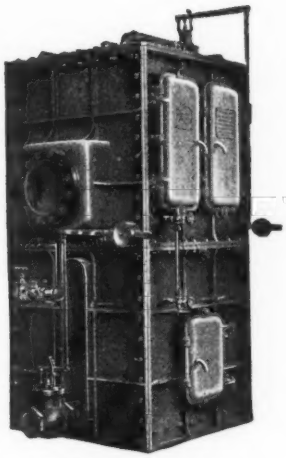
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

**Cocks, Gage**

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., P. B., Philadelphia, Pa.

THE actual-contact method of transmitting heat involved in the open heater is ideal, says an authority on feed water heating in a recent article. "The degree of perfection which the open heater has attained has eliminated formerly objectionable features, and has enabled open heaters to make records which cannot be approached with closed heaters."

# The Webster Feed Water Heater And Purifier



Webster Feed Water Heater

together with the Webster Oil Separator is by far the most efficient open type heater ever designed. It sends the purified water, added to by clean exhaust condensation into the boiler at the highest possible temperature, using only enough exhaust steam to obtain the desired heat. It is *not* a thoroughfare, exhaust-wasting heater.

Where the water supply is particularly bad the Webster Chemical Purifier gets perfect results.

Write for Heater Booklet 12-F; Separator Booklet 12-S; Chemical Purifier Booklet 12-C.

## WARREN WEBSTER & COMPANY

CAMDEN, NEW JERSEY

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Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.

**Cocks, Steam**
Homestead Valve Mfg. Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Coils, Pipe**
Fairbanks Co., New York.
National Pipe Bending Co., New Haven, Conn.

**Compound, Boiler**
Binghamton Boiler Compound Co., Binghamton, N. Y.
Bird-Archer Co., New York.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Coralline Drug & Chemical Co., New York.
Dearborn Drug & Chemical Co., Chicago, Ill.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.
Lagonda Mfg. Co., Springfield, Ohio.

**Compound, Lubricating**
Cook's Sons, Adam, New York.
Houghton & Co., E. F., Philadelphia, Pa.

**Condensers**
Alberger Condenser Co., New York
Baragwanath & Son, Wm., Chicago, Ill.
Deane Steam Pump Co., Holyoke, Mass.
Epping-Carpenter Co., Pittsburg, Pa.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., New York.

**Consumers, Smoke**
Climax Smoke Preventer Co., Boston, Mass.

**Controllers, Electric**
General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa

**Controllers, Feed Water**
American Boiler Economy Co., Philadelphia, Pa.

**Cooling Apparatus, Air**
De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.

**Cooling Plants**
Schutte & Koerting Co., Philadelphia, Pa.

**Cooling Towers**
Alberger Condenser Co., New York.
Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

**Correspondence Schools**
American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

**Couplings, Clutch**
Williams Fdry. & Mach. Co., Akron, Ohio

**Covering, Pipe and Boiler**
Carey Co., Philip, Cincinnati, O.
Houghton & Co., E. F., Philadelphia, Pa.
Johns-Manville Co., H. W., New York.
U. S. Mineral Wool Co., New York.

**Covering, Pulley**
Houghton & Co., E. F., Philadelphia, Pa.

**Crabs**
Yale & Towne Mfg. Co., New York.

**Cranes**
Yale & Towne Mfg. Co., New York.

**Die Stocks**
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.

**Draft Apparatus, Mechanical**
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

**Dressing, Belt**
Cling-Surface Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.
Harris Oil Co., A. W., Providence, R. I.
Houghton & Co., E. F., Philadelphia, Pa.
Johnson Co., Henry, Jersey City, N.J.
Rhoads & Son, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Philadelphia, Pa.

**Dressing, Rope**
Cling-Surface Co., Buffalo, N. Y.

**Drills, Upright**
Barnes Co., W. F. & John, Rockford, Ill.

**Dust Collectors**
Sturtevant Co., B. F., Hyde Park, Mass.

**Dynamos**
Clark Bros. Co., Belmont, N. Y.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

**Educational**
American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

**Ejectors**
Beggs & Co., James, New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.

**Engine Stops**
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

**Engineers and Contractors**
Lammert & Mann, Chicago, Ill.

**Engines, Blowing**
Wisconsin Engine Co., Corliss, Wis.

**Engines, Corliss**
Bates Machine Co., Joliet, Ill.
Beggs & Co., James, New York.
Cooper Co., C. & G., Mt. Vernon, O.
Griffith & Wedge Co., Zanesville, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Providence Eng. Works, Providence, R. I.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Wetherill & Co., Robert, Chester, Pa.
Wheeler Condenser & Engineering Co., New York.
Wisconsin Engine Co., Corliss, Wis.

**Engines, Gas and Gasolene**
Alberger Co., A. H., Buffalo, N. Y.
Buckeye Engine Co., Salem, Ohio.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Fairbanks Co., New York.
Foos Gas Engine Co., Springfield, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.

**Engines, Gas and Gasolene**—*Continued.*
Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Wisconsin Engine Co., Corliss, Wis.

**Engines, Hoisting**
Wisconsin Engine Co., Corliss, Wis.

**Engines, Oil**
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.

**Engines, Rolling Mill**
Wisconsin Engine Co., Corliss, Wis.

**Engines, Rotary**
Ball-Cooley Engineering Co., New York.

**Engines, Steam**
American Engine Co., Bound Brook, N. J.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., Elizabethport, N. J.
Bates Machine Co., Joliet, Ill.
Buckeye Engine Co., Salem, Ohio.
Clark Bros. Co., Belmont, N. Y.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Phoenix Iron Works Co., Meadville, Pa.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Machine Co., Pittsburg, Pa.

**Exhaust Heads**
Burt Mfg. Co., Akron, O.
Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Patterson & Co., F. L., New York.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Whitlock Coil Pipe Co., Hartford, Conn.

**Fans, Electric**
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

**Fans, Exhaust and Ventilating**
Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

**Fans, Ventilating, Mine**
Jeffrey Mfg. Co., Columbus, O.

**Feeders, Boiler**
American Boiler Economy Co., Philadelphia, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Lunkenheimer Co., Cincinnati, O
Myers & Bro., F. E., Ashland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

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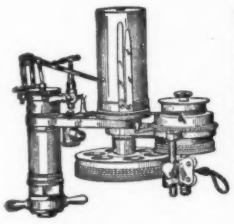

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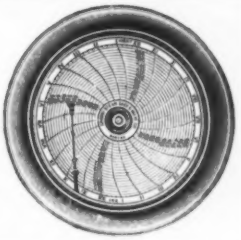

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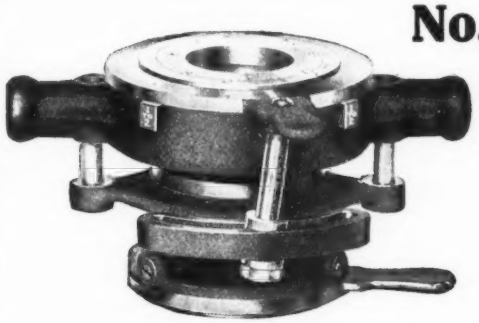

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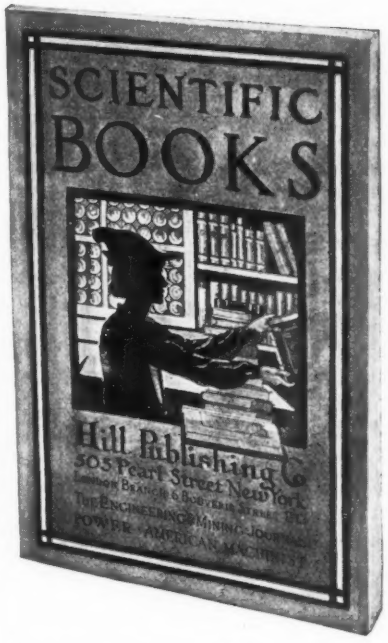


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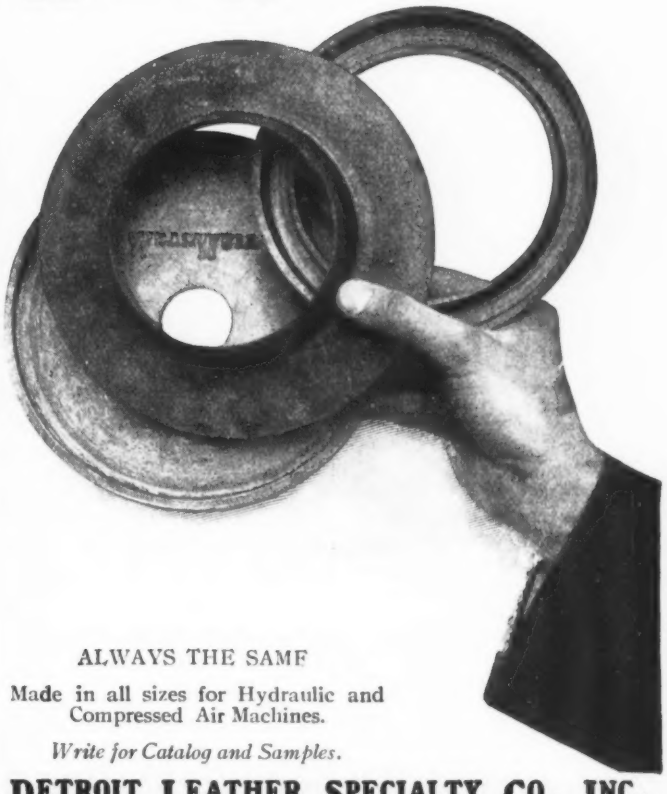

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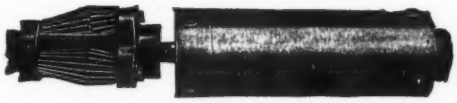

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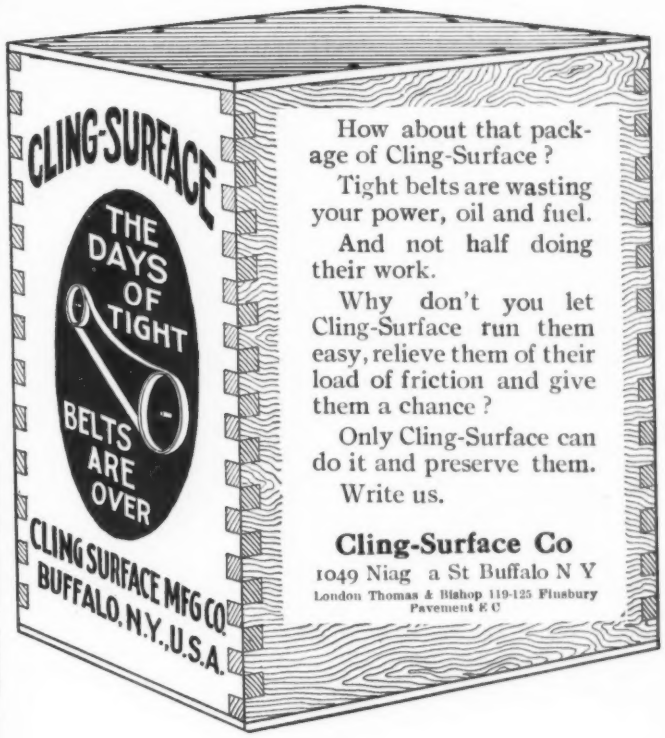


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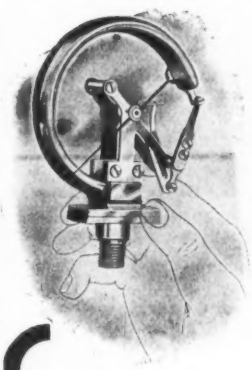

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Hoffman, Geo. W., Indianapolis, Ind.

**Presses, Hydraulic**

Watson-Stillman Co., New York.

**Publishers**

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.
System Co., Chicago, Ill.

**Pulleys**

Fairbanks Co., New York.
Houghton & Co., E. F., Philadelphia, Pa.
Myers & Bro., F. E., Ashland, O.
Reeves Pulley Co., Columbus, Ind.
Saginaw Mfg. Co., Saginaw, Mich.

**Pulleys, Clutch**

Williams Fdry. & Mach. Co., Akron, Ohio.

**Pumps, Air**

Du Bois Iron Works, Du Bois, Pa.
Lammert & Mann, Chicago, Ill.
Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser & Engineering Co., New York.

**Pumps, Boiler Feed**

Kewanee Boiler Co., Kewanee, Ill.
Warren Steam Pump Co., Warren, Mass.
Worthington, Henry R., New York.

**Pumps, Centrifugal**

Wheeler Condenser & Engineering Co., New York.
Worthington, Henry R., New York.

**Pumps, Compound**

Warren Steam Pump Co., Warren, Mass.

**Pumps, Deep Well**

Du Bois Iron Works, Du Bois, Pa.
Warren Steam Pump Co., Warren, Mass.

**Pumps, Electric**

Du Bois Iron Works, Du Bois, Pa.

**Pumps, Force-feed Oil**

Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.

**Pumps, Hydraulic**

Warren Steam Pump Co., Warren, Mass.
Watson-Stillman Co., New York.

**Pumps, Mining**

Du Bois Iron Works, Du Bois, Pa.

**Pumps, Oil**

Deming Co., Salem, O.
Detroit Lubricator Co., Detroit Mich.
Du Bois Iron Wks., Du Bois, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

**Pumps, Power**

Blake Mfg. Co., Geo. F., New York.
Patterson & Co., F. L., New York.

**Pumps, Pressure**

Deane Steam Pump Co., Holyoke, Mass.

**Pumps, Steam**

Blake Mfg. Co., Geo. F., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Du Bois Iron Works, Du Bois, Pa.
Epping-Carpenter Co., Pittsburg, Pa.
Gardner Gov. & Sep. Co., Quincy, Ill.
Lammert & Mann, Chicago, Ill.
McGowan Co., John H., Cincinnati, O.
Myers & Bro., F. E., Ashland, O.
Stewart Heater Co., Buffalo, N. Y.
Union Steam Pump Co., Battle Creek, Mich.
Wheeler Cond & Eng. Co., New York.

**Pumps, Triplex**

Deming Co., Salem, O.

**Pumps, Turbine**

Alberger Condenser Co., New York.
Worthington, Henry R., New York.

**Pumps, Vacuum**

Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser & Engineering Co., New York.

**Punches, Hydraulic**

Watson-Stillman Co., New York.

**Purifiers, Steam**

Hoppes Mfg. Co., Springfield, O.

**Purifiers, Water**

*See Heaters and Purifiers.*

**Pyrometers**

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Bristol Co., The, Waterbury, Conn.

**Re-cooling Plants**

De La Vergne Machine Co., New York.

**Recording Instruments**

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage and Valve Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Standard Gauge Mfg. Co., Foxboro, Mass.

**Reducing Wheels**

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty and Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Trill Indicator Co., Corry, Pa.

**Regulators, Damper**

Berry Engineering Co., Chester, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Watson & McDaniel Co., Phila., Pa.

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American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Phila., Pa.

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American Boiler Economy Co., Philadelphia, Pa.
Davis Co., John, Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Iowa.
Foster Engineering Co., Newark, N. J.
Lagonda Mfg. Co., Springfield, Ohio.
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Robertson & Sons, Jas. L., New York.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Phila., Pa.

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**Regulators, Water**

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**Repairs, Engine Room**

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Schuchardt & Schutte, New York.

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Houghton & Co., E. F., Philadelphia, Pa.
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National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
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Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.

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Houghton & Co., E. F., Philadelphia, Pa.

**Scales, Coal Hopper**

Fairbanks Co., New York.

**Scales, Wheelbarrow**

Fairbanks Co., New York.

**Schools, Correspondence**

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

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Baragwanath & Son, Wm., Chicago, Ill.
Beggs & Co., Jas., New York
d'Este Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Ohio Blower Co., Cleveland, O.
Patterson & Co., F. L., New York.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
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Watson & McDaniel Co., New York.
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Williams Valve Co., D. T., Cincinnati, O.

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Johns-Manville Co., H. W., New York.

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Fisher Governor Co., Marshalltown, Ia.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
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McClave-Brooks Co., Scranton, Pa.
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Westinghouse Machine Co., Pittsburg, Pa.
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Ohio Brass Co., Mansfield, Ohio.

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Eastwood Wire Mfg. Co., Belleville, N. J.
Erie Mfg. & Supply Co., Erie, Pa.
Foster Engineering Co., Newark, N. J.
Ohio Blower Co., Cleveland, O.
Ohio Brass Co., Mansfield, Ohio.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

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General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Switches, Electric**

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Bristol Co., Waterbury, Conn.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

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Reeves Pulley Co., Columbus, Ind
Saginaw Mfg. Co., Saginaw, Mich.

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Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Houghton & Co., E. F., Philadelphia, Pa.
Jenkins Bros., New York.
Kitts Mfg. Co., Oswego, N. Y.
McCrea & Co., James, Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Ohio Blower Co., Cleveland, O.
Platt & Co., John, New York.
Reliance Gauge Column Co., Cleveland, O.
Strong, Carlisle & Hammond Co., Cleveland, O.
Sturtevant Co., B. F., Hyde Park, Mass.
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Curtis & Curtis Co., Bridgeport, Conn.
Lagonda Mfg. Co., Springfield, O.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

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Johns-Manville Co., H. W., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.

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General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Machine Co., Pittsburg, Pa.

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Jefferson Union Co., Lexington, Mass.
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Pittsburgh Valve and Fittings Co., Barberton, O.

**Valves, Ammonia**

York Mfg. Co., York, Pa.

**Valves, Automatic Cut-off**

Lagonda Mfg. Co., Springfield, O.

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Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Jenkins Bros., New York.
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Liberty Mfg. Co., Pittsburg, Pa.
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Crosby Steam Gage & Valve Mfg. Co., Boston, Mass.
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**Valves, Pop Safety**

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Pittsburgh Gage & Supply Co., Pittsburg, Pa.

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Schutte & Koerting Co., Philadelphia, Pa.

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Walch & Wyeth, Chicago, Ill.

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Schutte & Koerting Co., Philadelphia, Pa.

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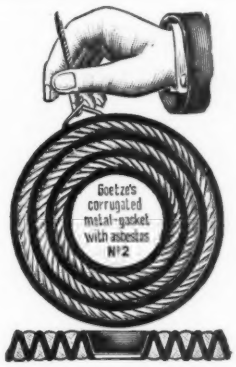


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THESE illustrations show a few of our standard, high grade, Spiral, Ring and Sheet Packings, which we manufacture for use in Locomotives, Steamships, Paper Mills, Saw Mills, Mines and Mill Engines of all kinds.

We have doubled the capacity of our Packing Department, at the Factory and are equipped to make Packings to meet any condition at short notice. Write for samples and Engineers' Catalogue, showing our full line.

Magic Diagonal

**Branches**

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150 Lake St.
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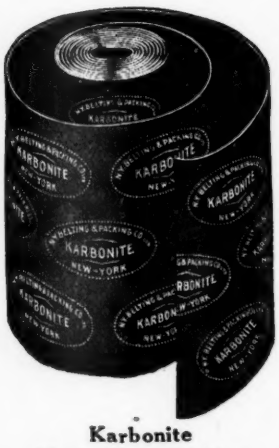
**NEW YORK BELTING & PACKING COMPANY, LTD.**

**91-93 CHAMBERS STREET, NEW YORK**

Indestructible White Sheet Packing




Karbonite Black Sheet Packing

Ruby Red Sheet Packing

# THE REASON WHY OUR PACKINGS ARE UNEQUALLED

We use nothing but the very best material which is made up into all the wanted styles of packing by skilled and accurate workmen.

Making our packings from the best stuff we can buy, in the most expert manner, is the *open secret* why Johnson's Packings are best. The *quality* of our packings is more than "skin deep"—*it goes clear through.*

*Write for packing Catalog.*

## THE HENRY JOHNSON COMPANY,

JERSEY CITY, NEW JERSEY.

# BELMONT 1903 EXPANSION

*Style 1* PACKING

## BELMONT 1903 EXPANSION

**STYLE 1**

is the slickest thing in the packing line ever made. Its great advantage over all others is

The *Three Break Joint*, and you can see from the cut just how it works. The two sliding wedges are independently movable within the casing; before placing the ring in position pull one forward and the other one back. In position then, the ring is practically solid, and one ring of BELMONT EXPANSION No. 1 will prevent escape of steam or ammonia as effectively as three rings of any other packing.

The sliding wedges offer another advantage in that very slight gland pressure causes them to slide over each other and hug the rod tightly. Gives 50% draw as against 10% in solid packings.

For shallow stuffing boxes BELMONT EXPANSION PACKING is a positive necessity, and for any conditions of steam and ammonia service up to 125 lbs. pressure its use means *economy* and *convenience*. Write for booklet *A*. and a free sample. (For pressures exceeding 125 lbs. use BELMONT HIGH PRESSURE No. 50. Booklet *B*. and sample free on request.)

**FREE** Send for sample ring and be convinced. **FREE**

CLEMENT RESTEIN CO., Philadelphia, Pa.
*Gentlemen:*—Send me a sample ring of Belmont Expansion Packing No. 1.

Name.....
St. No.....Town.....State.....
Firm Name.....
Number of Engines.....
Number of Pumps.....
Number of Boilers.....
High or Low Pressure.....
Packing now in use.....

POWER, Dec. 8, '08

## CLEMENT RESTEIN CO.,

133 N. SECOND ST., PHILADELPHIA, PA.

Mfgrs. of every variety of Packing and Gaskets. General Catalog on request.

## Salesmen Wanted

To call at power plants, pumping stations and engine rooms and sell BELMONT PACKINGS and Specialties. Particularly attractive proposition for manufacturers, agents and engineers in territory not already covered.

**CLEMENT RESTEIN CO.,**

133 N. Second Street, PHILADELPHIA, PA.

ENGINEERS WHO HAVE USED

# INDIAN RED SHEET PACKING

Will tell you it has the

STAYING AND RESISTING QUALITIES

It is efficient in every respect
which, in the end, means economy.

A 14 x 28 hanger, like cut herewith, but in colors,
free to any engineer upon request.

## The DIAMOND RUBBER CO., AKRON, OHIO.

**Complete Diamond Stocks Carried By**

The Diamond Rubber Co. of N. Y.,
1876 Broadway, N. Y.
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1523 Michigan Ave., Chicago, Ill.
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Buffalo Mill Supply Co.,
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Mobile, Ala.
Consumers Rubber Co.,
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# VANDA

A STEAM PACKING THAT IS A STEAM PACKING

TRADE MARK. REG. IN U. S. PAT. OFF.

All Goods Stamped with the VANDA TRADE-MARK will fulfill the claims we make for them.

# VANDA SHEET PACKING

THIS PACKING IS THE PIONEER OF ALL COMPOSITION PACKINGS, AND IMITATORS ARE APPEARING IN GREAT NUMBERS. WE THEREFORE, WOULD ESPECIALLY CALL YOUR ATTENTION TO OUR

## TRADE-MARK DEVICE STAMPED ON EVERY SHEET

GOODS MADE IN SHEETS ONLY OF 4½' x 4½' AND 4½' x 9', IN ALL THICKNESSES

THE VANDA COMPANY, 96 SPRING STREET, N. Y.

H. W. JOHNS-MANVILLE CO., CO-DISTRIBUTORS

# FOSTER VALVES

To secure the best possible results of increased economy and greater efficiency and safety in the steam plant, good judgment must be exercised in the selection of steam specialties—FOSTER.

Non-Return Stop Valve

A Foster Non-return Stop Valve eliminates the likelihood of fatality in case a cock should blow off, or one of the battery of boilers become disabled, by automatically shutting this particular boiler off from the rest and thereby preventing a back rush of steam from the others. Our numerous other steam specialties will appear in subsequent issues.

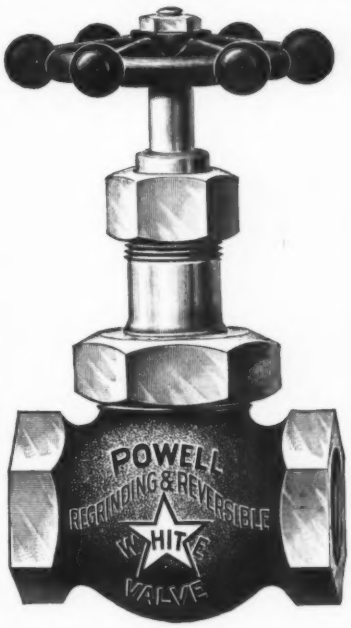
*Write for catalog.*

**FOSTER ENGINEERING COMPANY,**
**NEWARK, N. J.**

Room 304, No. 40 Dearborn St., Chicago, Ill.
403 Harrison Bldg., Philadelphia, Pa.
S. S. Stewart, 1245 Park Building, Pittsburg, Pa.
Stock carried at
50 and 52 S. Canal St., Adkins, Young and Allen Co., Chicago, Ill.

# THE POWELL "WHITE STAR" VALVE

**Renewable, Reversible and Regrindable**




The only valve on the market today combining the above features.

The White Star Renewable, Reversible and Regrindable disc, being made of a peculiar white bronze, will resist high temperatures and the wearing action of superheated steam.

The reversible and renewable features alone make it the most economical valve on the market today.

**Specify Powell to your jobber and insist on getting what you specify.**

*LOOK FOR THE NAME*

**THE WM. POWELL CO.**
**CINCINNATI, OHIO**

New York, 254 Canal St. Philadelphia, 518 Arch St.
Boston, 239-245 Causeway St.

## You're Wanted

to write us immediately for a catalog which describes the Mason Reducing Valve. Send us your address.

**The Mason Regulator Company, Boston, Mass.**

# BLACK SQUADRON

A Cancos Santa Claus.

We'll send a "Santa" of our own
out Christmas Eve this year,
To carry just the articles
that please an engineer.
She's neat, and sweet, and should you
meet her, this is what she brings:
CANCOS METAL POLISH and
BLACK SQUADRON PACKING RINGS.

## The 4 Wedge PACKING

Try it in the stuffing box that always leaks — one where no other packing stands a chance. That's where the four wedge construction makes good. It enables BLACK SQUADRON PACKING to respond perfectly to every inequality of a rod or stem with minimum friction, and only finger tightening of the gland nuts. Best materials throughout — every particle lubricated. Keeps rods in perfect trim. Write for booklet.

## Cancos Metal Paste Polish

*Cost* only ⅛ that of liquid polishes; can't scratch, no acids, no explosives, no stains or bad odor on hands. Makes oldest metal shine like new with magical ease and quickness. Write for free sample.

**CANCOS MANUFACTURING CO.**
**Philadelphia, Pa.**

102 High St., Boston, Mass. 525 Third Ave., Pittsburg, Pa.
305 Plowman St., Baltimore, Md.

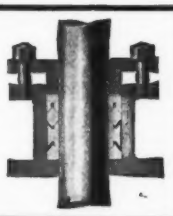
# PACKING WITH A BACKING

**National India Rubber Company**
**Factory, Bristol, R. I.**

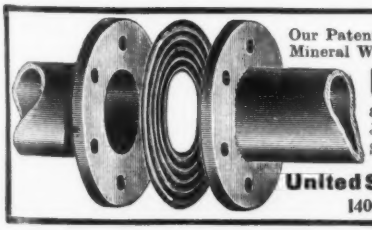
BRANCHES: 42 Broadway, New York. 84 Lake St., Chicago.
140 Essex St., Boston. 37 Hopkins Pl., Baltimore.
379 Washington St., Buffalo.

## THE "LAW" STANDS

as the simplest and best metallic packing. No springs are used. Write for a circular.



**HOUCHIN-AIKEN COMPANY**
Sole Manufacturers,
113-121 Fifty-Third St., Brooklyn, N. Y.



Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

**United States Mineral Wool Co.**
140 Cedar Street, New York

# Pittsburgh Iron Body Gate Valves

These valves are guaranteed to work under all pressures with less wear on the faces of the seats and discs than any other valve manufactured.

Those who desire a double gate will find their **ideal** in the "Pittsburgh." An adjustable wedge guided by ribs cast in the body, prevents the disc from scraping its faces. Thousands are in use for steam, oil, gas, water, gasoline and alcohol, and we have never had a single complaint.

*WE MANUFACTURE ALL KINDS OF VALVES AND FITTINGS. WRITE FOR CATALOG.*

**Pittsburgh Valve and Fittings Co.**
**General Offices and Works, BARBERTON, OHIO.**

## PUT US TO A TEST!

Try us out! Make us prove that the valves and pipage equipment we make have **very few equals** and **positively no superiors!** We are anxious that you do! We have been making good valves so long, and have been pleasing the most expert and most critical mechanics in such a large part of the civilized world for so long, that we are absolutely sure of our position!

From the very smallest and plainest valve, up to the very largest and most intricate piece of pipage, we turn out clear on top of the very highest pitch of perfection.

Some few of them are: Tuyeres, Tuyere Cocks, Regulators, Traps, etc.

*Send for Catalogue.*

**PITTSBURGH VALVE, FOUNDRY AND CONSTRUCTION COMPANY**
**PITTSBURGH NEW YORK BOSTON**
**CLEVELAND BIRMINGHAM, ALA.**

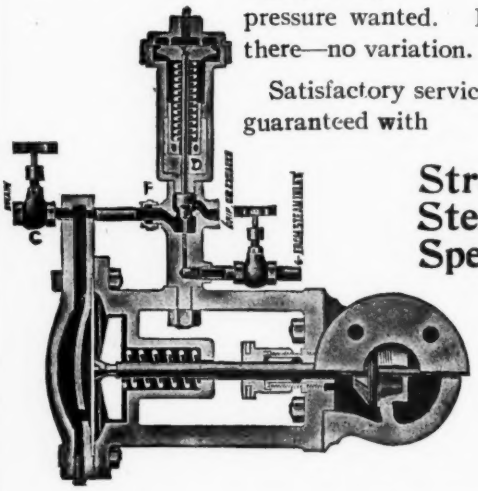
With our
## Reducing Valves

4/S

you do not need to consider the initial pressure. Set the valve at the pressure wanted. It's always there—no variation.

Satisfactory service is always guaranteed with

**Strong's Steam Specialties**



May we send our complete Catalog A?

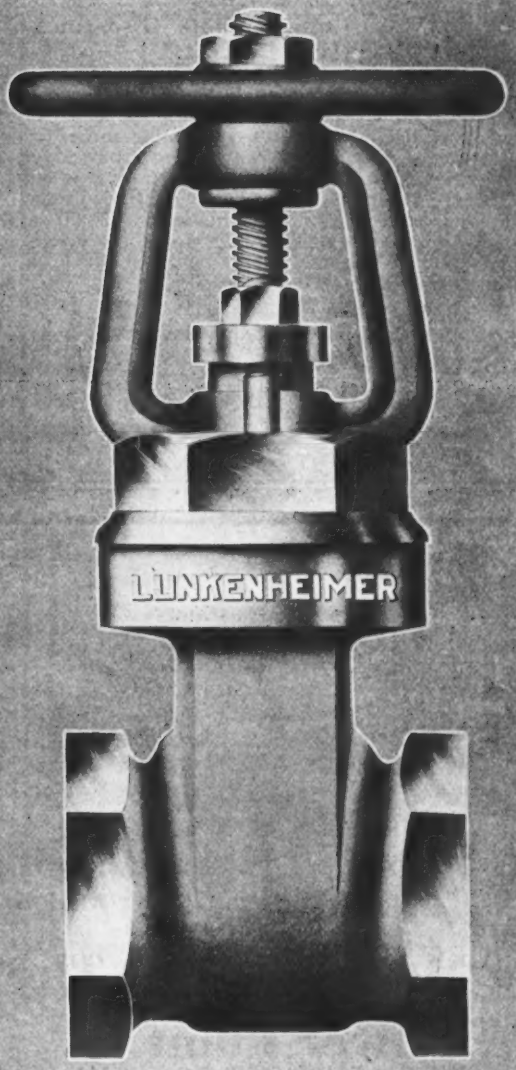
**The Strong, Carlisle & Hammond Co.,**
**342 Frankfort Ave., - Cleveland, Ohio**

88 Broad Street, BOSTON
54 No. 6th Street, PHILADELPHIA
261 Centre Street, NEW YORK

## LUNKENHEIMER WEDGE DISC GATE VALVES

Are made of a BRONZE COMPOSITION SUCH AS IS REQUIRED BY THE UNITED STATES NAVY. They are DOUBLE SEATED and will therefore take pressure from either end. The DISCS and SEATS and all other parts subjected to wear CAN EASILY BE RENEWED. Stuffing-boxes can be packed under pressure; the workmanship cannot be excelled and the valves have full area and are absolutely tight. Made with Outside Screw and Yoke or Stationary Stem; Medium Pattern for working pressures up to 200 pounds and Extra Heavy Pattern for 300 pounds working pressures. Our catalog will tell you more about them. It's free, write for a copy.

STATIONARY STEM




OUTSIDE SCREW AND YOKE

# The Lunkenheimer Company

Largest Manufacturers of High Grade Engineering Specialties in the World

General Offices and Works, Cincinnati, Ohio, U.S.A.

Branches: New York, 66-68 Fulton St.; London, S. E., 35 Great Dover St.; Chicago, Lake and Dearborn Sts.

499

## When You Buy Gate Valves Buy WILLIAMS.

YOU should be ever so particular about the kind of a gate valve you buy. Buying valves because they are cheap is mighty poor economy as they are a source of endless trouble and many repair bills. When again ordering valves, specify — Williams. It's a mark of Quality and your Protection against valve troubles. If your requirements call for a gate valve, to stand 200 pounds working pressure— please remember that the

**Williams Double Disc Gate Valve**

will fill your needs perfectly no matter how severe the service may be. This valve has two discs and seats — a double protection against leakage — and will take pressure from either side. Of excellent design, heavy construction, it is not affected by the strains of expansion or contraction and will therefore stand long and severe usage. It is the only valve that can be repacked under full pressure of steam or liquids without any danger of being burned or scalded in the operation

*Be safe and order Williams Valves.*

**THE D. T. WILLIAMS VALVE CO.**
904-910 Broadway, - CINCINNATI, OHIO
3

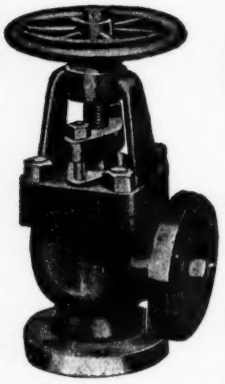
## ASHTON GAGES!

**THE ASHTON VALVE COMPANY, Boston, U.S.A.**
NEW YORK St. John's House, London, England. CHICAGO

## GIVE IT A QUARTER

turn—that opens or closes a Homestead Valve; the quickest, tightest and most durable valve made. *Catalog Free.*

**Homestead Valve Mfg. Co.**
**Pittsburg, Pa., U. S. A.**



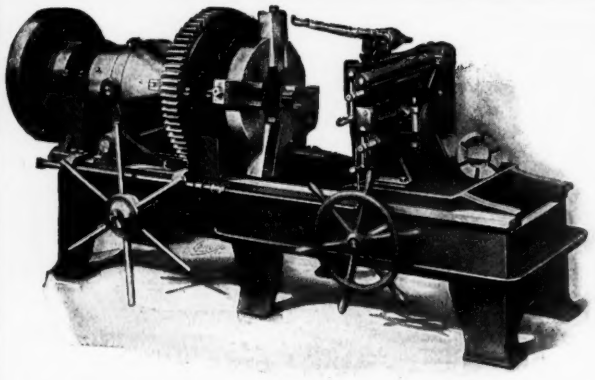
Manufacturers of the

## EDWARD VALVE

For High Pressures, Superheated Steam and Water.

**THE LAMMERT & MANN**
Oil Dash Pots for Corliss Engines, Gas and Gasoline Engines.

**LAMMERT & MANN,**
*ENGINEERS and MACHINISTS,*
157 S. Jefferson St. CHICAGO, ILL.



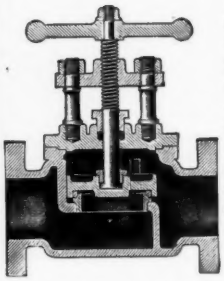
## Pipe Machines For The Power Plant

We can furnish any size your plant may require, either belt or motor drive, and we want your inquiries.

**Get the Catalog No. 17.**

**Bignall & Keeler Mfg. Co.**
**Edwardsville, Ill.**

## "BELLVILLE VALVES"

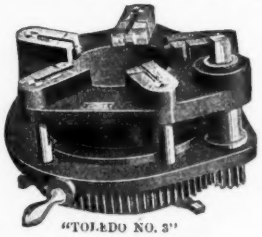


have the seat on the outside of an inverted cone where the direct current of steam does not come in contact with it, preventing all chance of wire drawing. Other features in catalog.

**Heavy, Compact, Durable,**
no marring by pipe tongs.

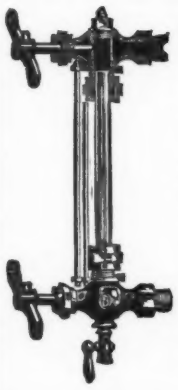
**Eastwood Wire Manufacturing Co.,**
**BELLEVILLE, NEW JERSEY.**

## EASY PIPE THREADING


"TOLEDO NO. 3"

with this *one-man-machine.* It weighs but 155 pounds and can be carried right to the work. Threads pipe from 4½" to 8" inclusive. Write for details.

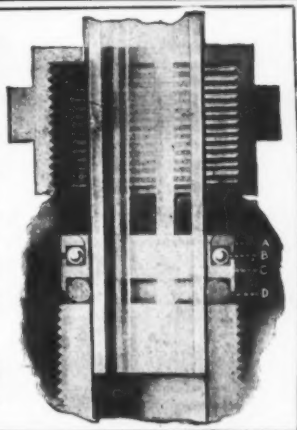
**THE TOLEDO PIPE THREADING MACHINE CO.**
TOLEDO, OHIO.



# "OHIO" WATER GAUGE

Made from High Grade Bronze, Finely Finished, Quick Opening.

A NEW FEATURE is the Ball Bearing Gland, shown herewith. ¶ The Packing Nut comes in contact with Rotating Ring "A" which travels around without friction over balls "B," thus the Rubber Gasket "D" is relieved of all twisting no matter how tightly it is compressed and makes it possible to make an absolutely tight joint without breaking glass. *Full Description and Prices on Request.*




**THE OHIO BRASS CO., MANSFIELD, OHIO, U. S. A.**

NEW YORK, 30 Church St. CHICAGO, 277 Dearborn St. SAN FRANCISCO, 138 Front St.

# THE ONLY FLANGE

**That Will Not Leak**

under any conditions is the welded flange, and the Ballwood Welded Flange is at once the best, cheapest and the most promptly delivered of all welded flanges on the market.

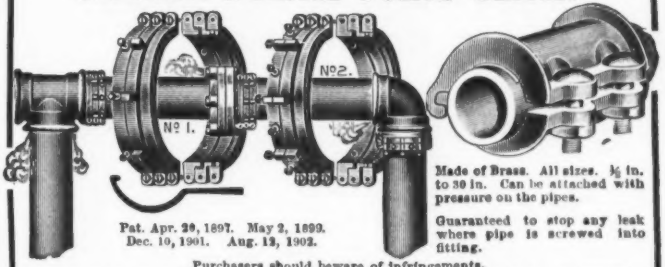
CIRCULAR No. 104.

**THE BALL & WOOD CO.,**
**Elizabethport, N. J.**

New York Sales Office—Cortlandt Building, 30 Church Street.

BUILDERS OF BALLWOOD ENGINES.

# PIPE REPAIRS for any condition
## CLIMAX STEAM JOINT CLAMP




Pat. Apr. 20, 1897. May 2, 1899. Dec. 10, 1901. Aug. 13, 1902.

Made of Brass. All sizes. ½ in. to 30 in. Can be attached with pressure on the pipes.

Guaranteed to stop any leak where pipe is screwed into fitting.

Purchasers should beware of infringements.

We manufacture the EMERGENCY PIPE CLAMP to repair splits and rust holes. The MODEL FLANGE CLAMP, for leaks between flanges, and the H. H. STEAM TRAP, best made.

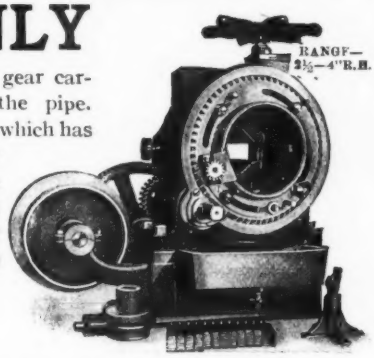
SEND FOR CATALOG.

**JAMES McCREA & CO.,**
61 to 65 W. Washington Street, - - CHICAGO

# THE ONLY

machine with receding gear carrying the dies onto the pipe. THE ONLY machine which has *shell* adjustment for taking up wear. One man operates it with better results than four men using the old-style stock and die.

*Write for Catalog.*




**THE CURTIS & CURTIS CO., 85 Garden St., Bridgeport, Conn.**

# Easily Connected, Disconnected Or Reconnected.

"Kewanee" Unions have no inserted parts. Write for further details.

"KEWANEE"
"The union with no inserted parts."

**NATIONAL TUBE COMPANY, Pittsburg, Pa.**

DISTRICT SALES OFFICES

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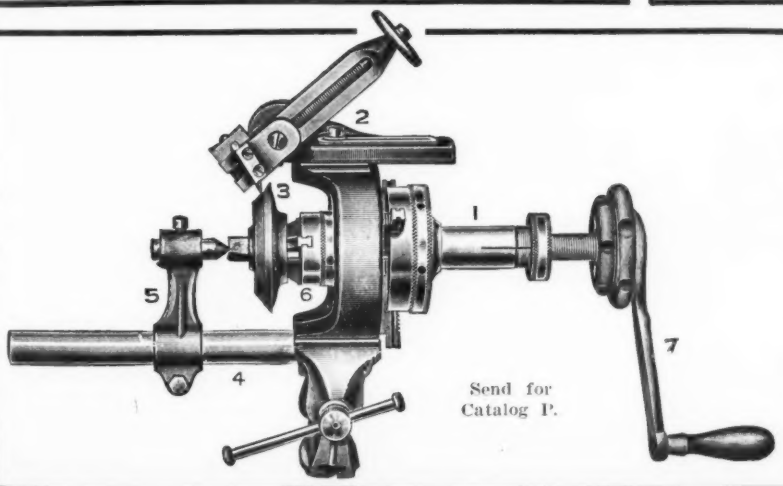



Send for Catalog P.

# DANGEROUS AS WELL AS EXPENSIVE

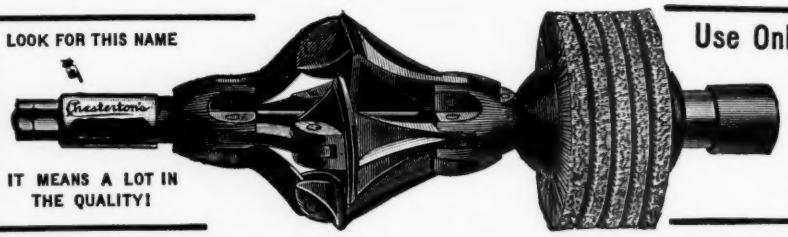
Concealed leaks often cause trouble wherever valves are used. By applying a

## Dexter Valve Reseating Machine

you'll discover valves badly out of true. They were leaking and you didn't know it. Every valve in the plant should be tested with a Dexter Machine. The operation is simple and then you'll know your valves are safe and sound.

**THE LEAVITT MACHINE CO.**
Orange, Mass., U. S. A.

LOOK FOR THIS NAME

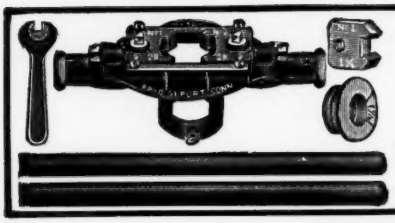



IT MEANS A LOT IN THE QUALITY!

Use Only the Genuine "COMBINATION"
Trade Mark Registered

**It Scrapes and Sweeps** the tubes in *one operation* and leaves them CLEAN.
*It saves its cost every time it is used.*

A. W. CHESTERTON CO., 64 INDIA STREET, BOSTON, MASS.
Or Advance Packing & Supply Co., 123 Franklin St., Chicago.



STOCKS AND DIES
PIPE MACHINES,
PIPE CUTTERS,
VISES.
Manufactured by
The Armstrong Mfg. Co.
287 Knowlton St.,
BRIDGEPORT, CONN.

Get Rid of Leaks

The Jefferson Flange has stood 3000 pounds per square inch. *Write.*

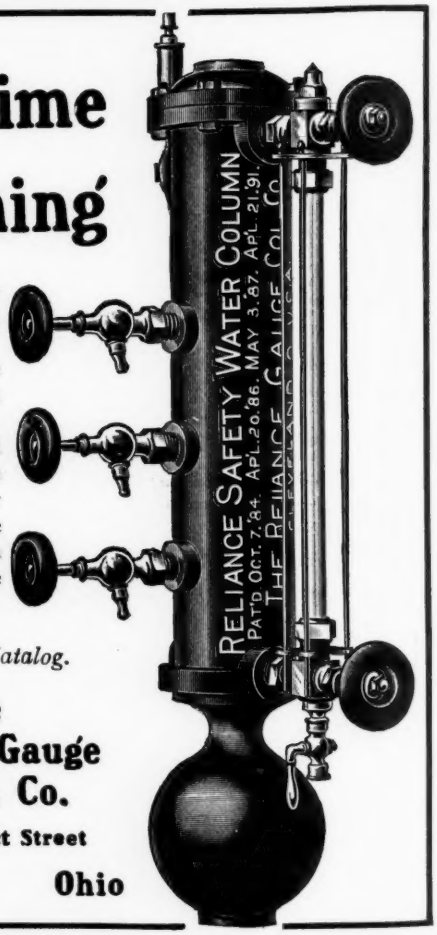
THE JEFFERSON UNION CO.
31-37 Fletcher St., Lexington, Mass.

The Time Is Coming

when the water level will rise too high, or drop too low.

That time *may* be your last moment on earth.

Prepare now and install the Reliance Safety Water Column — the one that sounds an alarm, when the level is dangerous.




*Write for Catalog.*

The Reliance Gauge Column Co.
75 E. Prospect Street
Cleveland, Ohio

Have one Free on 30 Days' Trial

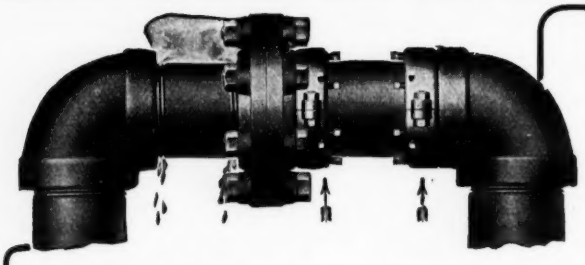
Keep Your Distance Sir

when the gauge glass breaks by having the

"P. B. H." Quick Closing Water Gauge.

You simply stand off at a safe distance and pull the chain. You can no more get scalded than if you pulled down a shade in your own home. It's just as simple.

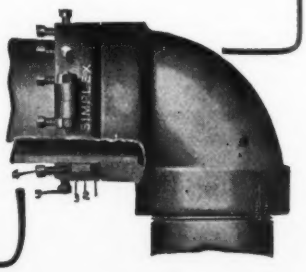
The Paul B. Huyette Co.,
2025 Betz Building, Philadelphia, Pa.



LEAKS STOPPED

Made Absolutely and Permanently Tight

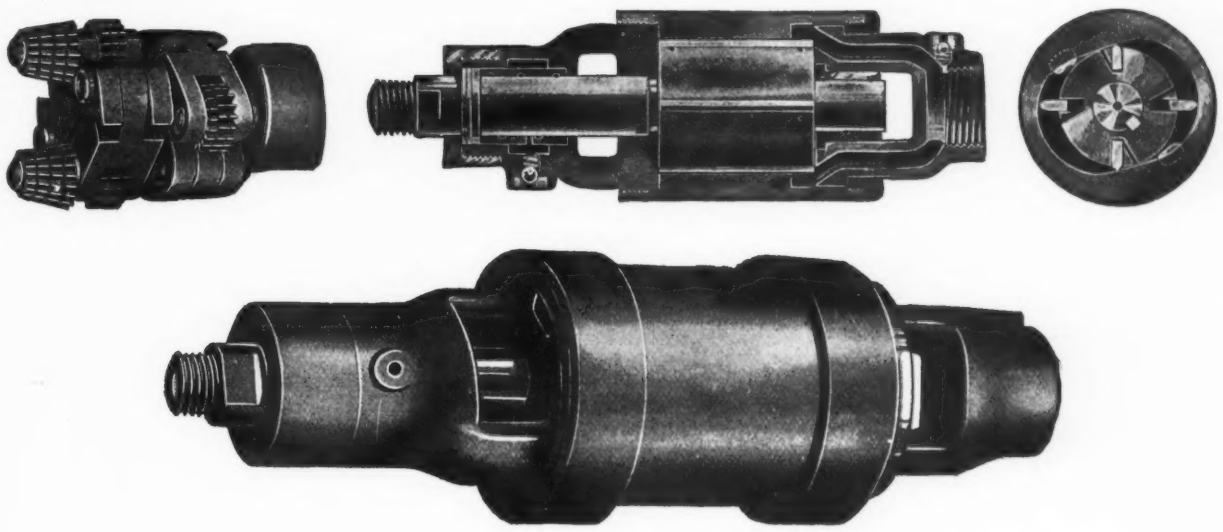
No matter how persistent the leak we guarantee the Simplex to secure the joint easily, quickly and effectually.




The cost is a trifle compared with the saving. Have one on trial?

The Simplex Engineering Co.
326 Preston Street PHILADELPHIA, PA.

# WEINLAND WING HEAD CLEANER
## DRIVEN BY COMPRESSED AIR



This is THE machine if you have compressed air in your plant, or if scarcity of water would make a turbine expensive to operate. The Wing Head is rotated at high speed by the action of the air on radial pistons. The motor is too powerful to permit the cleaning head to "choke" in thick scale, and the force of the air is very effective in blowing out the loosened scale particles.

## NO HAMMERING ACTION

Reciprocating Cleaners wear rapidly at the bearings. Further, the pounding action makes tube ends leak and often dents the tubes. *Weinland Cleaners positively will not harm the tubes.*

The wearing parts of our machine are carefully tempered and won't wear seriously. If they do, they are easily and quickly replaced. The forward bearing is close to the cleaning head, large and well lubricated, so the shaft won't wear loose.

We send this Air-Driven Wing Head Cleaner on trial. If you do not find it the best air driven cleaner you have used, send it back. Ask about the Weinland Mechanical Cleaner for extremely severe conditions.

Write for special bulletin and our free book, "Boiler Scale and Its Removal."

**THE LAGONDA MFG. CO., Springfield, Ohio**

**Makers of Weinland Turbine and Mechanical Cleaners, Lagonda Reseating Machines, Automatic Cut-Off Valves and Tube Cutters**

New York Philadelphia Pittsburg Chicago San Francisco Birmingham St. Paul Toledo London

(77)

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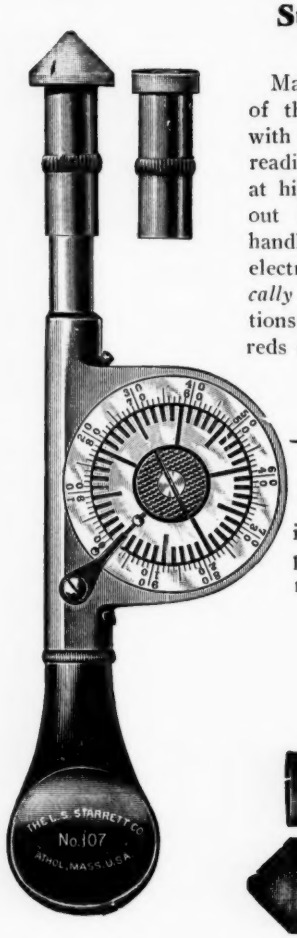
### Starrett's Registering Speed Indicator

Made in the best possible manner, of the best materials and is fitted with a dial having two rows of figures reading either right or left. Will run at highest speed of machinery without heating and has hard rubber handle for insulation when used on electrical machinery. It *automatically* registers the number of revolutions up to 5000 so that the hundreds do not have to be kept in mind.

**Given for two Weekly subscriptions**




### The Victor Pipe Wrench

This wrench will take pipe from ¼ to 1 inch; is made of tool steel and so designed that the jaw will always hold firm in place, yet can be adjusted instantly with one hand. You will find it the most convenient pipe tool that you ever used.

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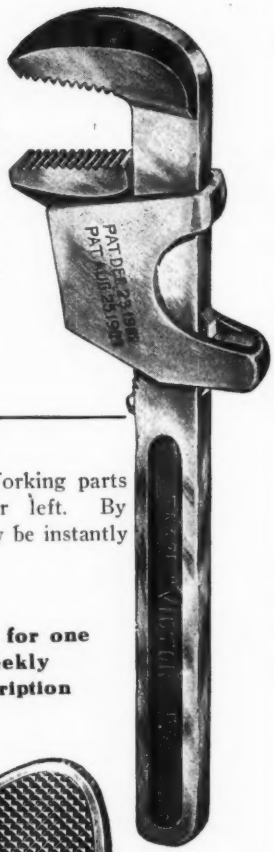


### Starrett's High Speed Indicator

May be run at highest speed required without heating. Working parts inclosed. Dial plate has two rows of figures, reading right or left. By pressure and twist of thumb, plate is loosened and "o" mark may be instantly moved to agree with starting point.

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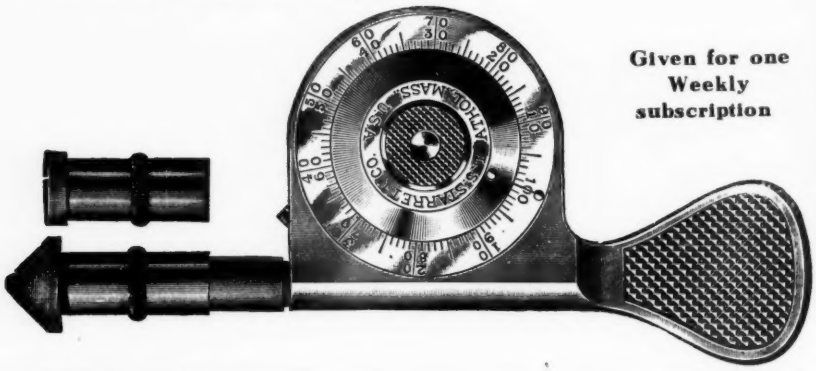


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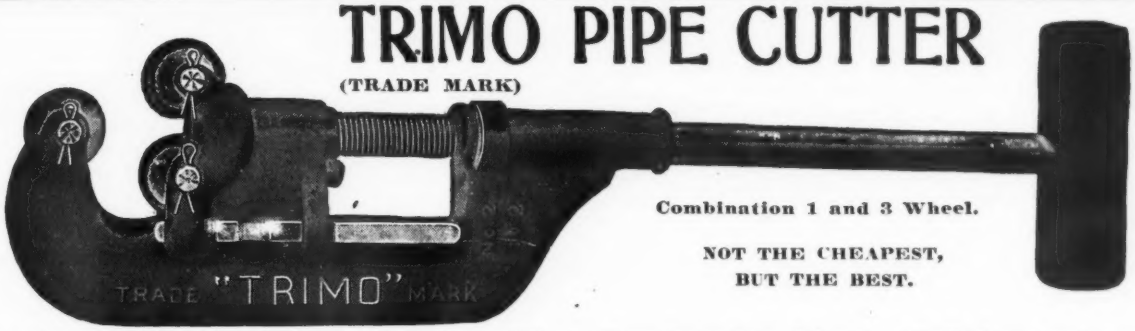
(TRADE MARK)

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THE largest contract ever awarded for steam pipe and boiler coverings specified Carey's. This was the result of an exhaustive test conducted by the Manhattan Railway Company of New York, which proved Carey's Coverings to be more efficient and far superior in every way to any other of the numerous makes. No other coverings proved to be as light, clean and substantial.

Carey's Coverings are absolutely fire-proof, and being thorough non-conductors of heat they confine the heat to the pipes, effectually preventing its loss through radiation, thus saving in fuel an amount sufficient to *more* than offset the cost of their application.

The most prominent steam users everywhere use Carey's Covering. Do you want to know why?

*Send for Carey's Magnesia Catalogue.* It gives information not obtainable elsewhere.

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Pennsylvania Flexible Metallic Tubing can truly be called a "*metallic snake.*" It is made of steel or copper tape, rolled into a continuous spiral with interlocking edges. Comes in all sizes from $\frac{1}{8}$" to 12" and is *ideal* for high pressures of all liquids, compressed air, steam, gases, ammonia, etc. An asbestos thread makes it tight. Circular?

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Added in small quantities to your oil, Dixon's Flake Graphite greatly increases its efficiency, lengthens the life of the bearing, prevents cutting and scoring in cylinders and *reduces friction*. Graphitize your oil with Dixon's and make less oil go a longer way. A sample can, No. 94-C, sent free on request.

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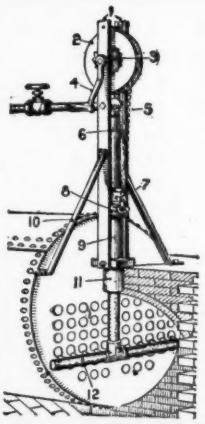

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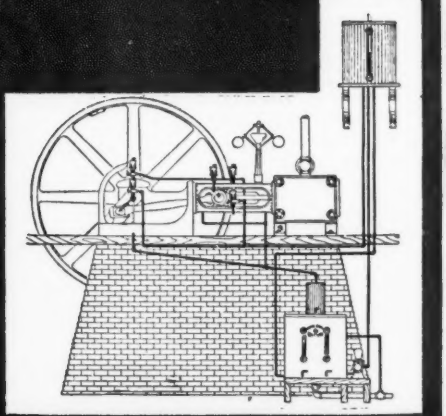

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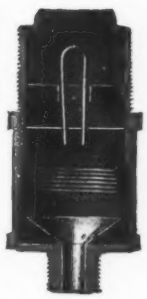
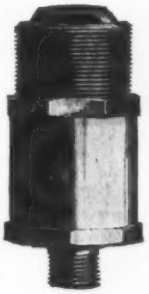


Automatic application of grease to the bearing without the use of spring compression. : : : :

**Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : :**



With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

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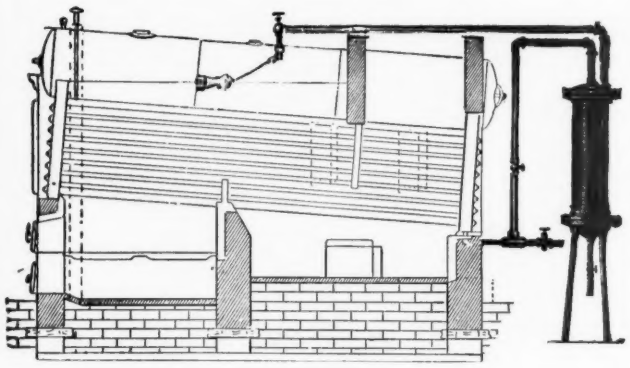

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That's where the Buckeye Boiler Skimmer floats—right on the water level inside the boiler and removes the scale-forming impurities by skimming the surface of the water.

That the "Buckeye" as a scale preventer is strictly *on the level* can be proved by you at no expense. We'll gladly send one to you for 30 days' free trial. Write for circulars.

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**OFFER DOUBLE PROTECTION AGAINST SCALE**

FIRST, they change scale forming elements chemically, mechanically or both to form a non-adhesive precipitate.

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Even if some particles escaped the first process they would surely be rendered harmless by the second, and sent to the bottom of the boiler to be drawn out through the blow-off.

Try BIRD-ARCHER COMPOUNDS for six months. If the results are not highly satisfactory, you can have your money back. Write for book: "Boiler Troubles and Their Prevention."

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The Drip Cock prevents it

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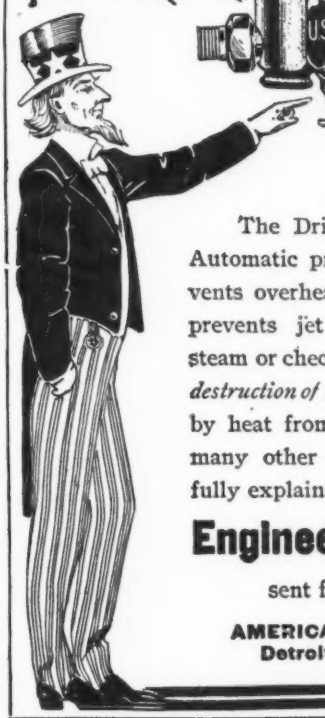

The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

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Cannot be beat for raising water from deep wells, mines or pits, filling or emptying tanks, raising or transferring liquids, etc.

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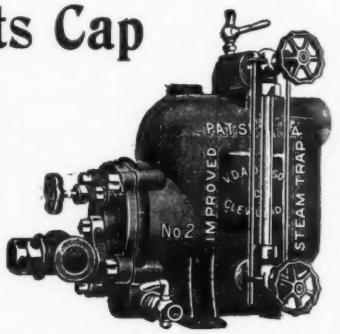


and the internal mechanism of the Anderson Improved Steam Trap can be quickly taken out and put back again without breaking a single steam joint or pipe connection. The "Anderson" is always positively locked with three inches of water. "Trap Book" free.

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ALL TROUBLE ARISING FROM WATER IN STEAM PIPES IS REMEDIED IN THE SIMPLEST MANNER BY THE APPLICATION OF THE

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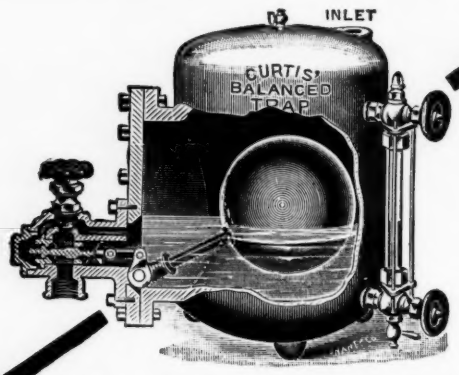


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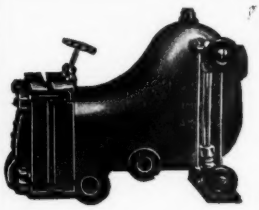

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are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

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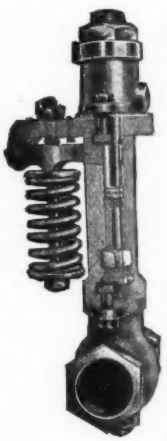

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

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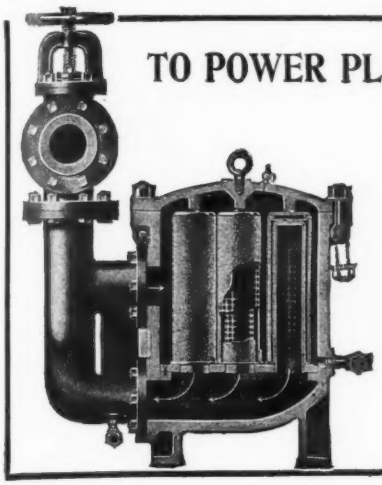

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**THE BLACKBURN-SMITH FEED WATER FILTER AND GREASE EXTRACTOR**

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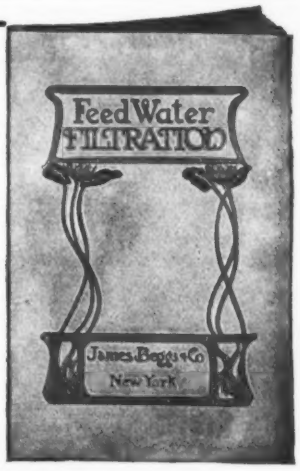


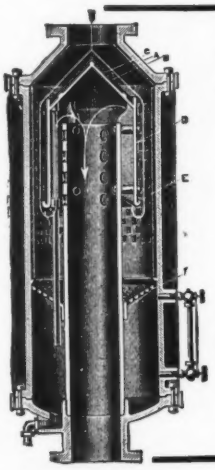

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Steam Separators deliver 99.8 dry steam and oil separators remove 99% of oil from exhaust steam. They *do* it that's all. All styles.

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Borrow the Baum Separator for a month and note results. It will remove all water, oil and grit from your steam—and if it doesn't do so in an entirely satisfactory manner to you, we'll take it back.
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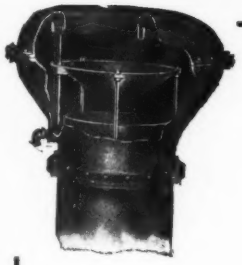
R. D. Bliss, 40 Dearborn St., Chicago, Ill.



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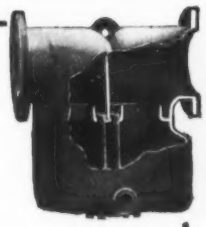

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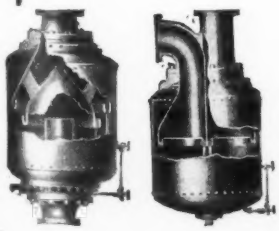

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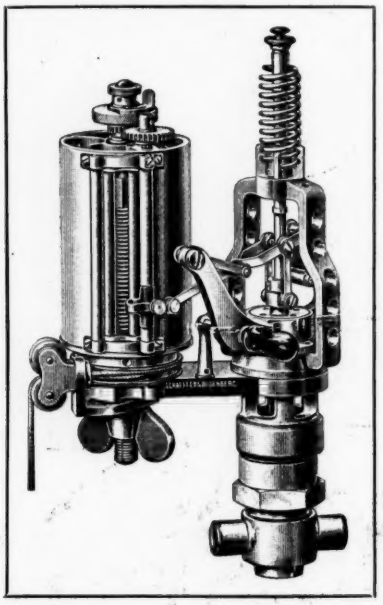

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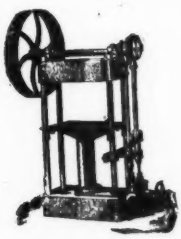

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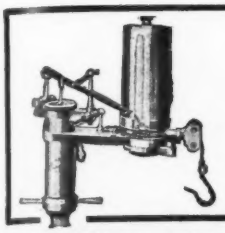

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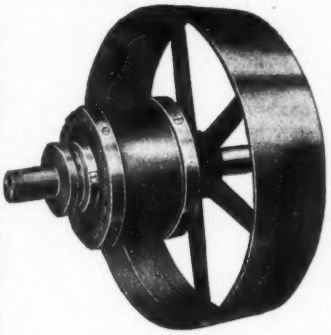

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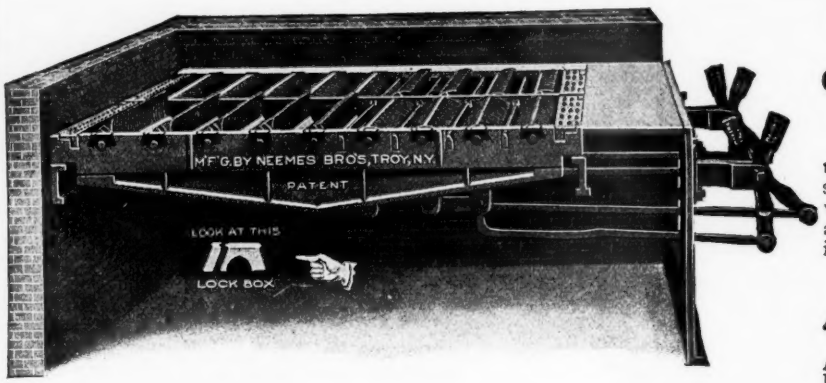


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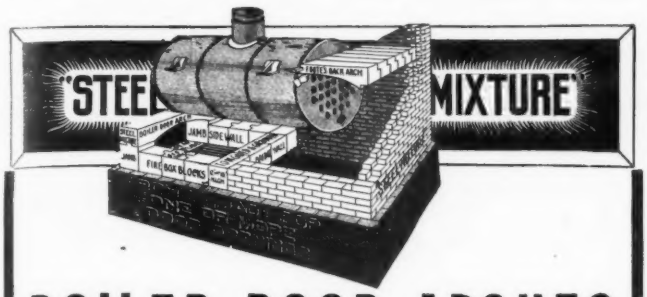


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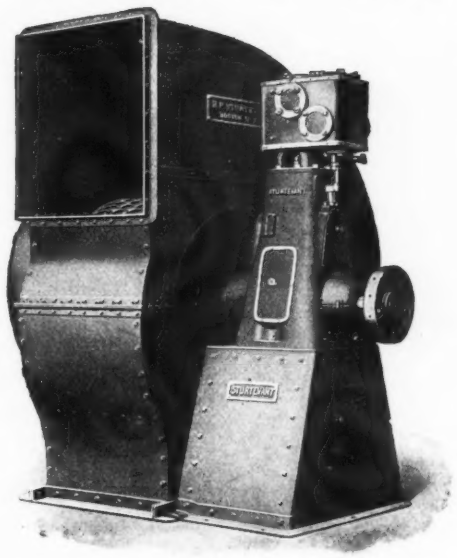

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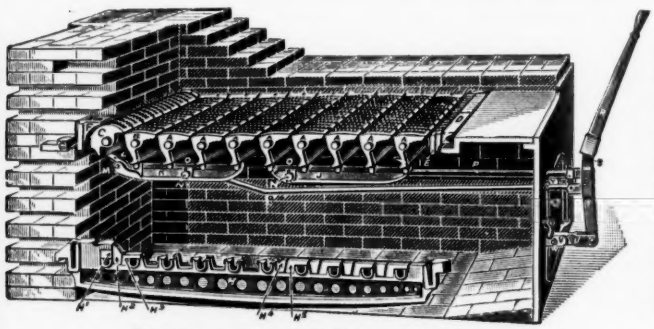


Plate No. 1. Normal Position of Grate.

Plate No. 2. Shaking Movement.

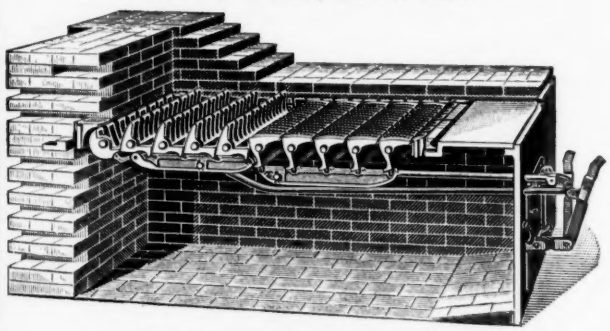


Plate No. 3. Divided Cut-Off Movement.

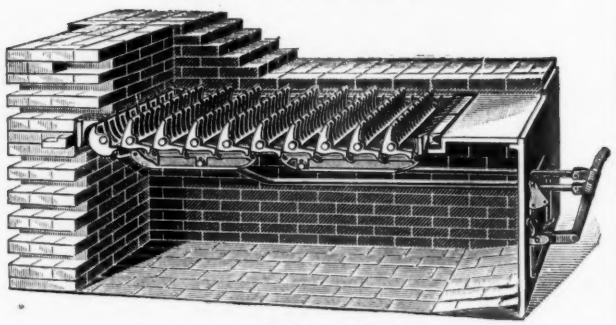
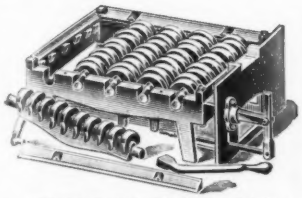


Plate No. 4. Whole Cut-Off Movement.



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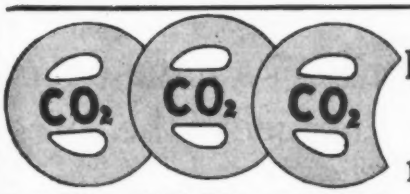


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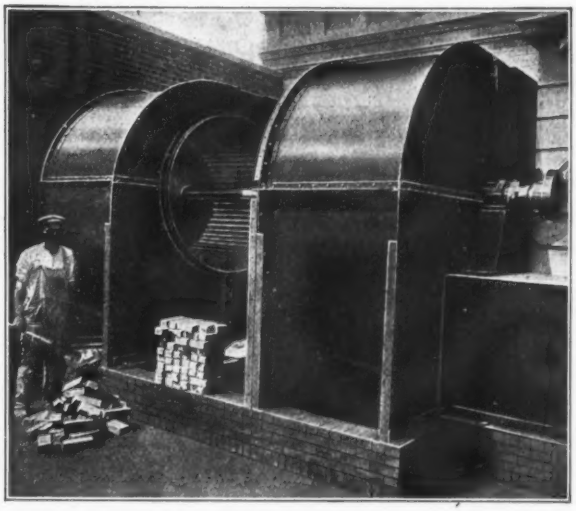

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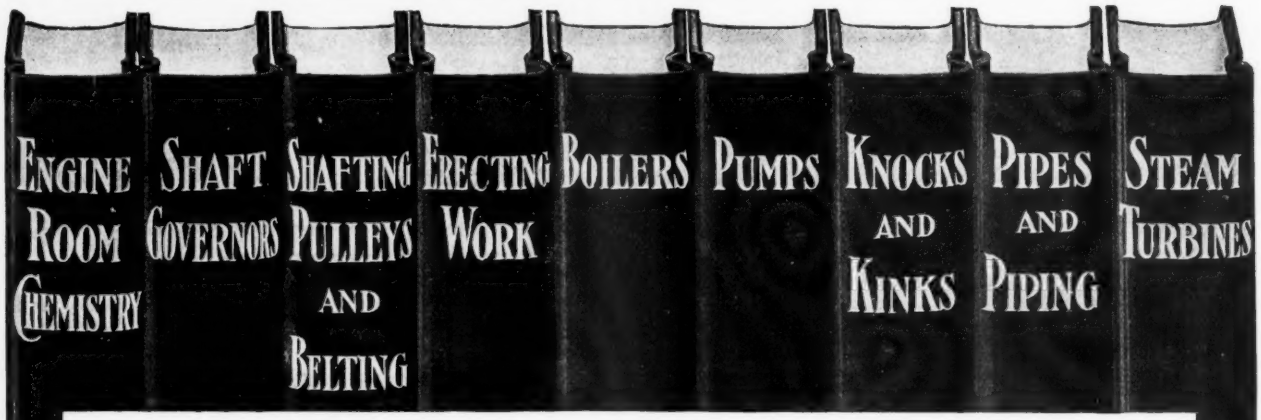


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In either case the International Correspondence Schools can help you. There's a way that fits your case exactly. To find out what it is, simply mark the attached coupon and mail it today. No charge for the information and advice it brings—no obligation.

The Business of the I. C. S. is to Raise Salaries by imparting to poorly paid but ambitious men, in their spare time, the knowledge that fits them for their natural line of work. The proof of this is in the fact that every month an average of 300 men voluntarily report promotions and better salaries received as the direct result of I. C. S. training, and this is but a small percentage of the whole number helped.

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Please explain, without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

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| Telephone Engineer | Foreman Molder | Window Dresser |
| Civil Engineer | Foreman Blacksmith | Chemist |
| Bridge Engineer | Marine Engineer | Sheet-Metal Draft. |
| Mechanical Engineer | Hydraulic Engineer | Ornament. Design. |
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go with the Otis Feed Water Heater and Purifier. You're protected on all sides—we take all the risk. All we ask is your permission to install this heater. If you don't like it, we'll come and take it out. It needn't cost you a red cent to **test it.**

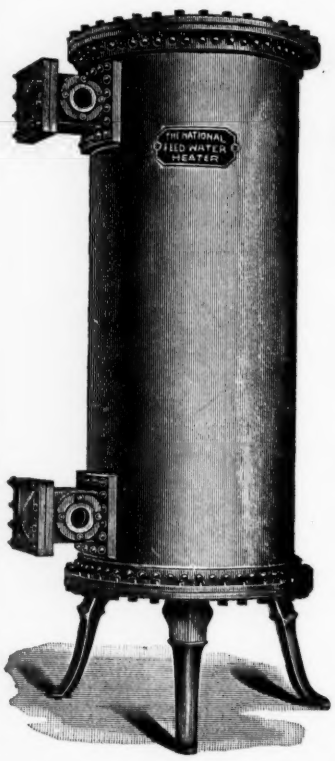
This heater, used with our feed pump, saves from 15 to 25% over an injector.

That's going some, hey?

Write today for our guarantees.

**THE STEWART HEATER COMPANY,**

**45 E. DELAVAN AVENUE, BUFFALO, N. Y.**




**The Simplest Heater Made**

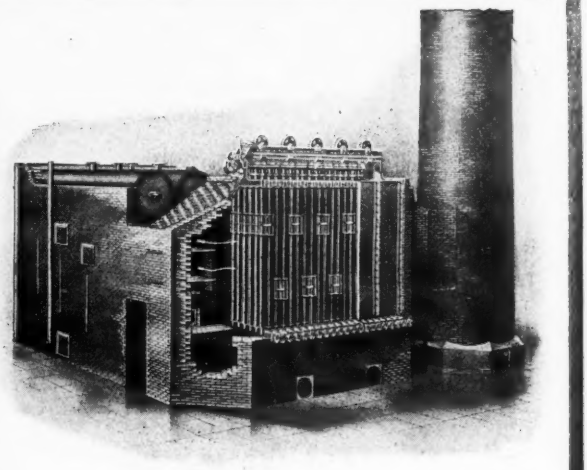
yet the most effective because it has no inside joints to leak, no contact of water with shell or other iron parts and because it absolutely insures against back pressure, grease in the boiler and waste of fuel.

*Write To-day*

**The National Pipe Bending Co.**

**175 Lloyd St., New Haven, Conn.**

120 Liberty St., New York 54 High St., Boston, Mass.



# DISTRIBUTION OF HEATING SURFACE for ECONOMICAL STEAM PRODUCTION.

The Green Economizer is virtually a part of the boiler surface. But it transmits more heat per square foot than would boiler surface in the same place, because its contents are cooler than those of the boiler. The "temperature head" between it and the flue gases is greater.

Therefore, if a certain number of square feet of heating surface are to be installed per pound of coal burnt per hour or per boiler horsepower, it is better that part of that surface be in an economizer than that it all be in the boilers.

The combination of boiler and economizer will not only make more steam per pound of coal, but it will cost less, will be cheaper to keep up and will last longer. The economizer is a specially devised arrangement for heating feed water and for abstracting heat from low temperature gases. It is not injured by expansion and contraction strains, it automatically frees itself of soot, and it precipitates impurities from the water in the form of a soft sludge which is easily removed.

The last advantage is important in another way. When it is desired to clean the economizer, the flue gases and the feed water can be by-passed and *the economizer can be cleaned while the boilers continue to supply steam.* This is much better than having to lay off boilers in order to remove scale which could be stopped in an economizer.

Economizers can be added to an existing boiler plant to increase both its efficiency and its capacity. Enough economizer surface should be used to bring the water up to the boiler evaporating point. We shall be pleased to figure out the possible gain in your plant if you will send us the data. Ask for our new BOOK "106P."

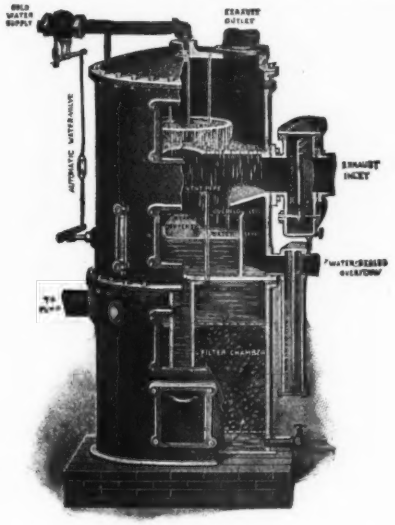
**The Green Fuel Economizer Co.**

**MATTEAWAN, N. Y.**

**New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.**

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 124

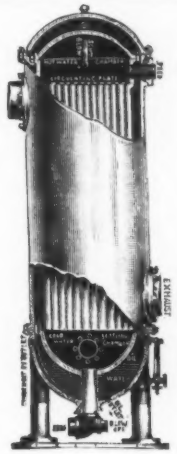
## THE WHITLOCK OPEN EXHAUST
### Feed Water Heater and Purifier



**Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.**

**Manufactured by**

**THE WHITLOCK COIL PIPE COMPANY**
**HARTFORD, CONN.**
New York Office—Singer Building, 85 Liberty Street.



## A Heap More Heat From Your Coal Heap!

Install a Riblet Feed Water Heater and your coal heap will last longer. By introducing feed water at a temperature of 210° into your boiler, you can string along the coal that ordinarily would be exhausted at once to heat the water to that degree.

The "Riblet Heater" differs from the others—it's better in many ways. It's more than a shell and a few tangled tubes.

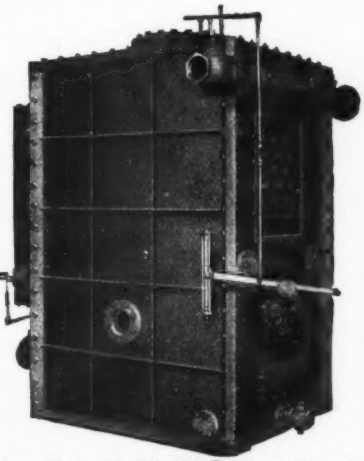
WRITE FOR CATALOG.

**Erie Mfg. & Supply Co.,**
**1203 Peach Street, Erie, Penna.**

## How To Get Along With Less Fuel

The way is easier than is generally supposed. It simply means installing the Loew Boiler Feed Water Heater, which purifies the feed water and *heats* it to within 2 to 5 degrees of the exhaust steam. Scale is prevented and less fuel is required to generate a given amount of heat.

Every "Tom, Dick and Harry" Heater will not do this. Get the "Loew" and secure *positive results.*



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**The Loew Mfg. Co.,**
**Cleveland, Ohio.**
New York Representative, G. L. Todd, 50 Church Street.

## A Couple of Shells To Keep It Hot

That's the secret of the anti-steam-loss obtained by the

**Baragwanath Steam Jacket Feed Water Heater**

It consists of a shell within a shell forming a steam jacket around the tubes and absolutely preventing radiation. Thus it gets all the value from your exhaust. Catalog?

**WM. BARAGWANATH & SON,**
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# Harrisburg Feed Water Heaters

Of Pure Seamless Copper Coils. Guaranteed to be the most effective, most durable and cheapest heater manufactured.

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**COPPER, IRON AND BRASS PIPE COILS AND BENDS OF ANY DESIRED SHAPE**

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**The Harrisburg Pipe & Pipe Bending Co.**

950 HERR STREET, HARRISBURG, PA.

Manufacturers of HIGH GRADE

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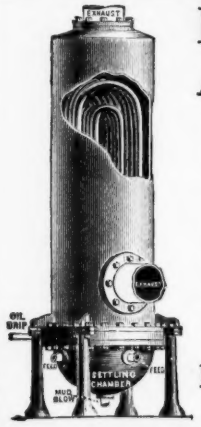
**PIPE**

BLACK AND GALVANIZED




# By Removing A Few Bolts

the settling chamber and tube plate may be lowered, exposing the interior of the **Patterson-Berryman Feed Water Heater and Purifier** without disconnecting the heavy exhaust pipes or disturbing the shell, thus permitting inspection, thorough cleaning, repacking of joints, etc.

60 days' free trial. Write.

**Frank L. Patterson & Co.**

28 Cortlandt St., New York.

**Every Coil a Spring**

# Reilly Multicoil

## FEED WATER HEATER

IN AN ADVERTISEMENT we cannot describe all the advantages of this heater. We therefore ask you to write for our Catalog.

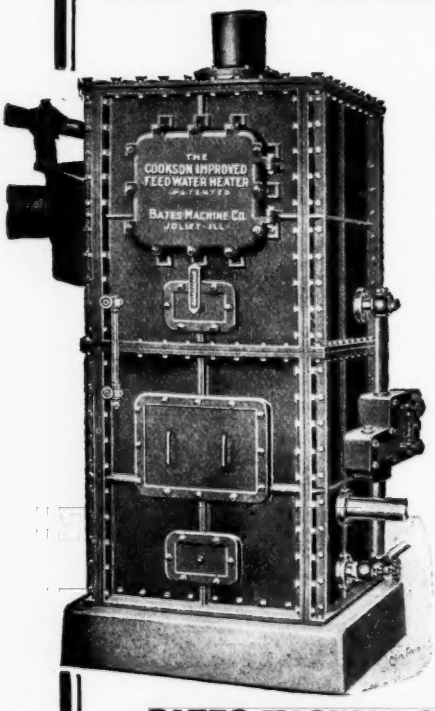
**The GRISCOM SPENCER CO.**

90 WEST ST., NEW YORK.

The Reilly Oil and Grease Exractor.

Agents: Russel Engines—Tudor Boilers
Mfgrs: Tanks—Special Machinery of all kinds

# COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS




Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

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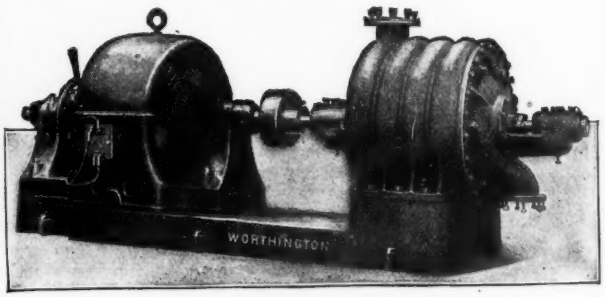
**BATES MACHINE COMPANY**

**Sole Manufacturers** **Joliet, Illinois**

# OUR TURBINE PUMPS




**ARE** SIMPLE
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EFFICIENT
WELL CONSTRUCTED

**Require very little attention.**
**Built to suit your conditions.**

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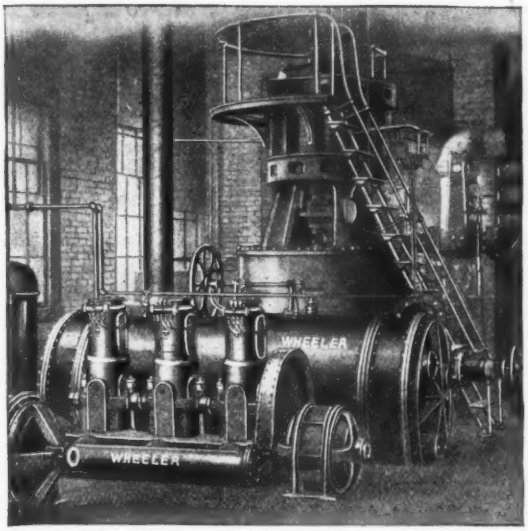
Works; Harrison, N. J.




# Power Consumption of Air Pumps

High vacuum is a great thing, especially for steam turbines, since about 25% of the steam consumption of turbines can be cut off above 26 ins. vacuum. Many people, however, have the impression that it is poor engineering to strive after good vacuum. This belief is usually based on the high power consumption of ordinary air pumps when made large enough or driven fast enough to give a reasonably high vacuum. The work of driving an ordinary air pump is mostly friction, and a friction-producing air pump bucket should be run as slowly as possible.

THE WHEELER-EDWARDS AIR PUMP, however, can be run at high speeds as well as at low speeds. The piston is vertical and therefore does not ride on the side of the pump barrel, and as it is packed with grooves instead of rings, it scarcely touches the pump barrel at all. Therefore, the work of a motor driving the Wheeler-Edwards Pump is confined almost solely to compressing the air and discharging from the head valves.

WHEELER-EDWARDS PUMPS do not need to sweep as great a volume as the ordinary pump to dispose of the same volume of gases, since the entire volume swept is effective, due to the fact that the air and vapors flow into the pump barrel at once at the beginning of the stroke, instead of having to overcome the weight and inertia of valves and of water resting on valves.

Moreover, as the air is discharged before the water and there is almost no clearance, no air remains in the pump barrel to re-expand during the return stroke and prevent the taking in of fresh air from the Condenser.

The WHEELER-EDWARDS AIR PUMP will handle a much greater volume of air and give a much higher vacuum than any ordinary air pump; in fact, it will give as good or better results than the much more expensive, complicated and power consuming combination of separate hot well and dry vacuum pumps with air coolers, etc.

Write for our recently issued treatise "P 103" on Air Pumps.

We build Wheeler Surface, Jet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery. 28

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CONDENSER & ENGINEERING CO.
CARTERET, NEW JERSEY.

WARREN STEAM PUMP CO.,
Warren, Mass.
PUMPS FOR ALL REQUIREMENTS.
*PISTON HYDRAULIC* *DEEP WELL PLUNGER* *VERTICAL POWER*
Air Pumps and Jet Condensers.
Combined Air and Circulating and Marine.
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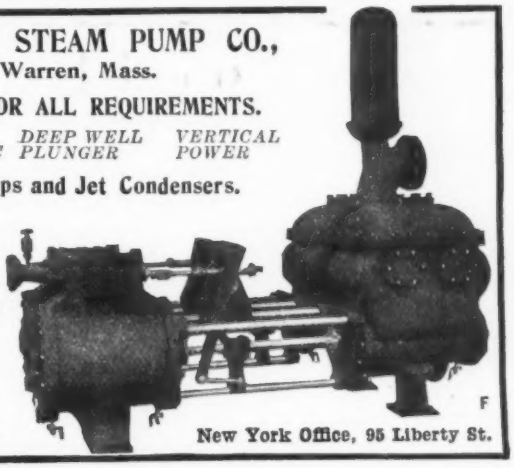


New York Office, 95 Liberty St.

Dean Bros. Steam Pump Works
INDIANAPOLIS

Simple Plunger Pump

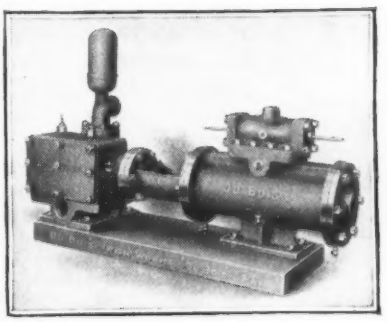
Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

That blank space, on the left, represents your blank look of amazement when you see how easily the Eclipse Live Steam Feed Water Heater and Purifier prevents scale. Write for details.

The Eclipse Feed Water Heater & Purifier Company,
Oshkosh, Wisconsin.

DUBOIS PUMPS

We Send Them On



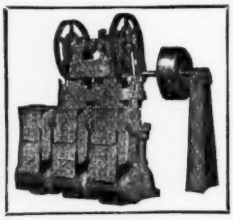
30 Days' Trial

Put them to any test. If they do not "make good" we'll take them back and shoulder all expense. DuBois Pumps are entirely automatic. They are unequalled for simplicity and durability. Write for particulars.

DU BOIS IRON WORKS,
Established 1877.
805 Brady Street, DU BOIS, PENNA.

**Deming**

Ask for Catalogue "G" and treatise "Feeding Boilers."



For any service. **Power**

For operation by any power. **Pumps**

**The Deming Company**

Agencies in Principal Cities

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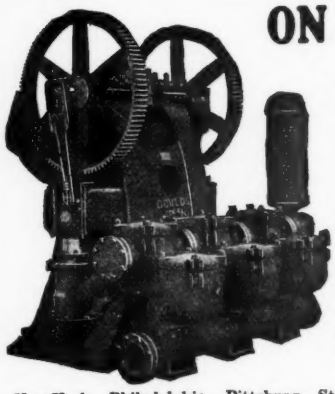

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of their extremely low cost of operation and the small amount of attention required

**Goulds Efficient Power Pumps**

are growing in favor wherever they are installed. Let us send you Catalog of Pumps for every service.

**The Goulds Mfg. Co.**

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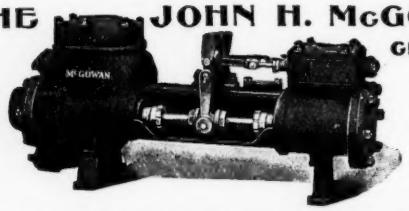

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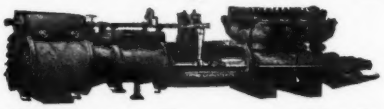
**Power Station Pumps and Condensers**



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**STEAM PUMPS**

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POWER PUMPS—AIR COMPRESSORS—CONDENSERS

**UNION STEAM PUMP CO.,**

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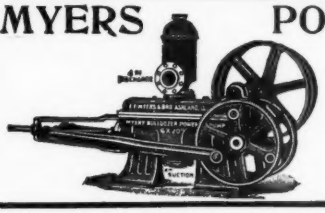
**MYERS POWER PUMPS**



Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.

Catalog sent on request.

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**Exhauster & Pump Primer**

These exhausters are used extensively for priming Centrifugal Pumps, Long Suction Pipes, Air Vessels, etc., and with 30 ft. of water pressure will overcome a suction up to 25 ft. They have no moving parts; are absolutely reliable; simple manipulation; low in cost and high in efficiency. When writing for price state length and height suction pipe, time in which to be evacuated, and pressure water.

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**Alberger Condenser Co.**

Condensers, Cooling Towers, Vacuum Pumps, Heaters

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Centrifugal, Volute, and Turbine Pumps

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**THE FISHER GOVERNOR**

is reliable under all conditions. It is in office in the best plants. Never gets out of order and controls *any pressure* up to 8000 lbs. per sq. inch.

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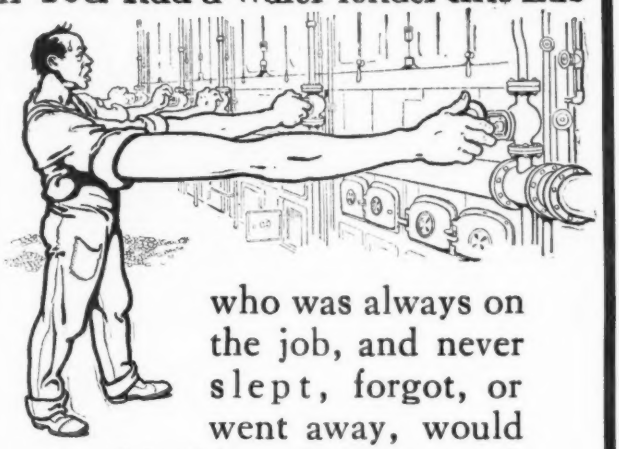
**THE FISHER GOVERNOR CO.,**

**MARSHALLTOWN, IA.**

# If You had a water tender like this



who was always on the job, and never slept, forgot, or went away, would you hire him at $10.00 a year?

The COPES BOILER FEED REGULATOR answers the requirements, it holds the water level absolutely constant, feeding the water as fast as evaporated, but no faster. It protects the boiler from the disastrous effects of low water and the engines from the dangers of water carried over with the steam. The boiler is not strained by sudden injections of large volumes of cold water, and the efficiency of feed water heaters and economizers is brought up to the maximum by reason of the uniform feeding.

At the same time the Copes Regulator is simple and reliable. It contains no internal levers, floats, pilot valves, springs and diaphragms. All the working parts are in sight where you can see what they are doing, and easily test their operation if you so desire.

Let us make an estimate on the equipment of your plant with Copes Regulators. Ask for our new Book P.

**The**

## American Boiler Economy Co.

**North American Bldg.,**
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27

**Davis Pressure Regulators Save Steam**

## PRESSURE Balanced by WEIGHT

That's the simple and never failing principle upon which the Davis Pressure Regulator operates. It has no springs, toggles, diaphragm or auxiliary valves in its make up. It accomplishes its purpose—the automatic reduction of pressure—by the most direct means and enables you to use steam at any pressure less than that of the boiler for auxiliary apparatus, heating, drying, cooking or any other purpose. When once set for a certain delivery, it automatically maintains that pressure constant regardless of boiler fluctuations.

Every Davis Pressure Regulator is backed with our positive guarantee to put a check on steam waste and to prove it we'll take all the chances. It has to make good, or it's your privilege to send it back at our expense. It's all we say it is, or the trial costs you nothing.

*Everything for the Automatic Regulation of pressure* is shown in our general catalog. Send for it.

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**142 Milwaukee Ave., Chicago.**

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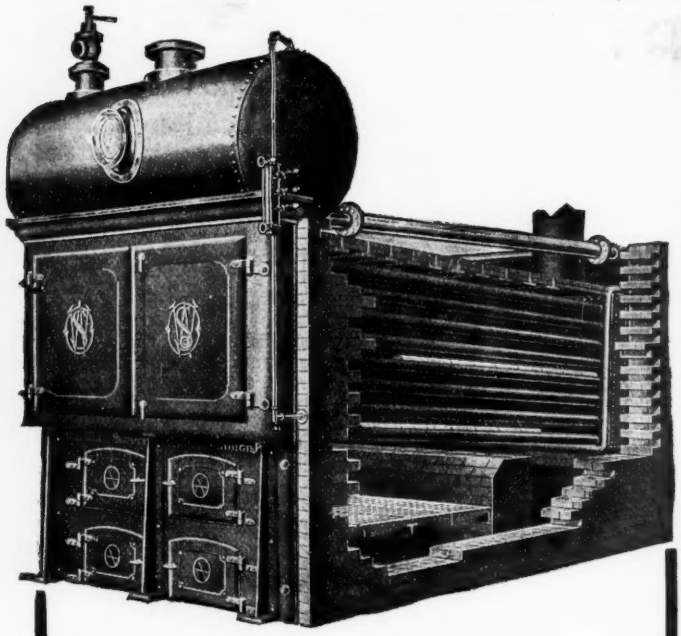

# The Basis Of Economy

in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

## Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

*Ask for illustrated catalog and latest test report.*

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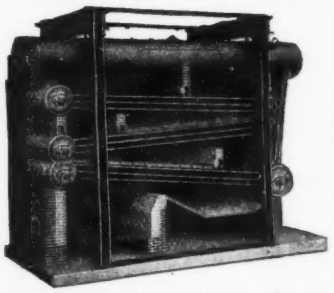
is more complete and effective in case of the Vogt Water Tube Boilers than in any other.

This boiler is composed entirely of steel and is so designed that no weight rests on the walls. Get all the particulars.



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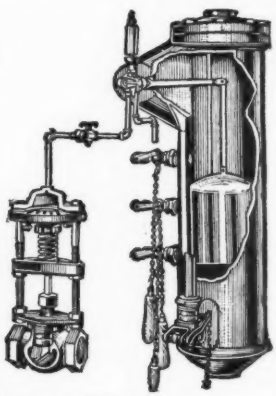

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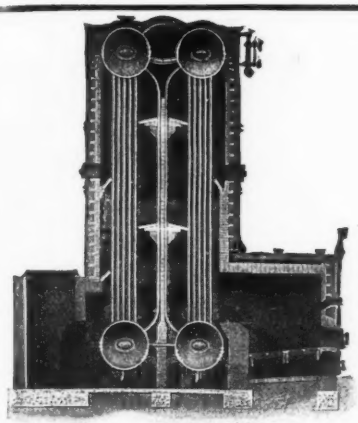

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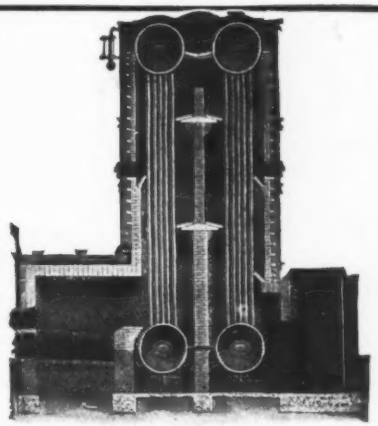

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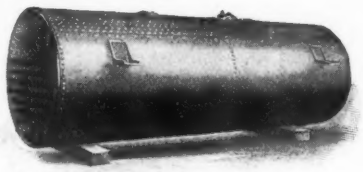

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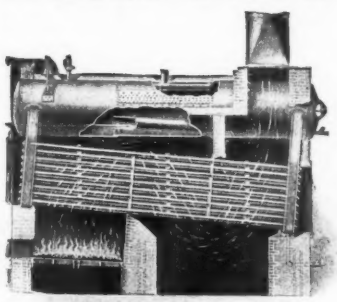

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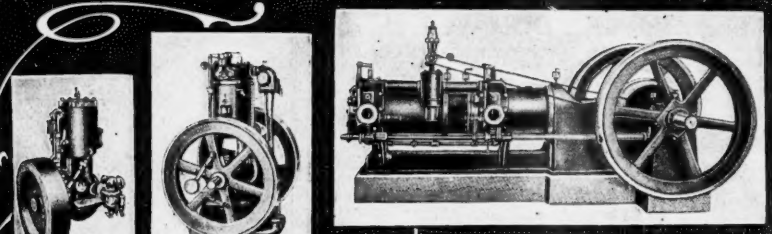

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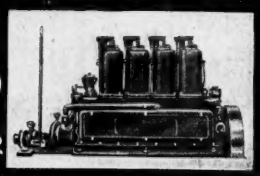

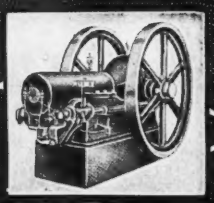

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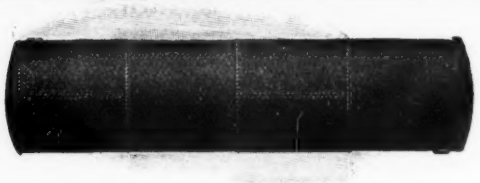

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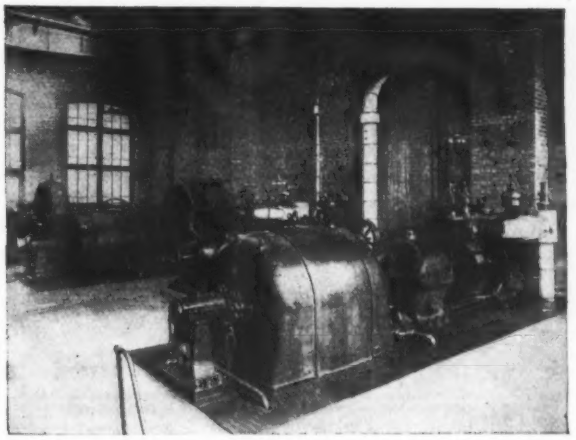

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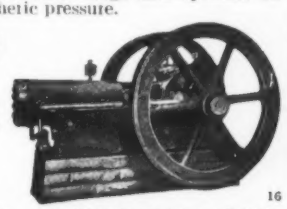

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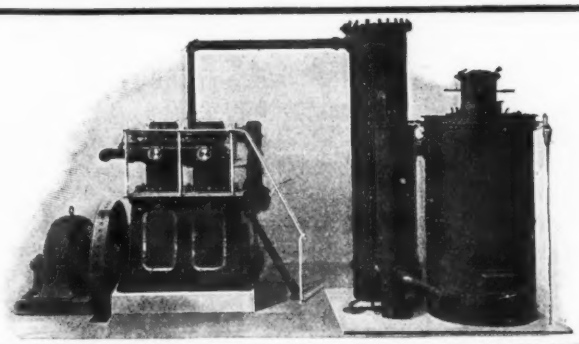

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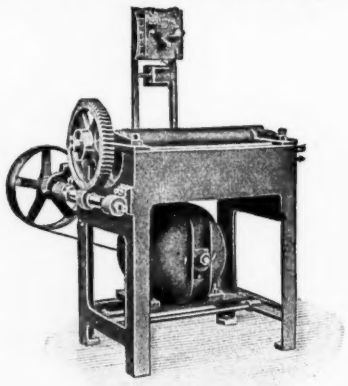

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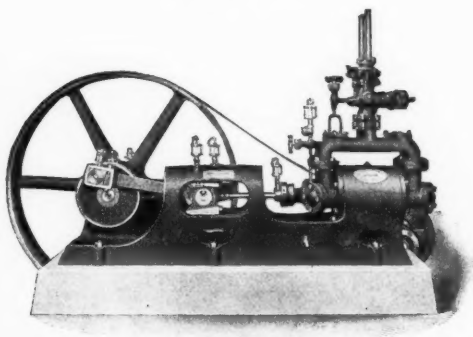

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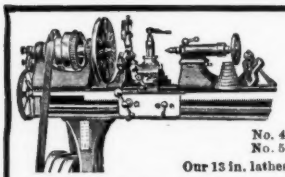

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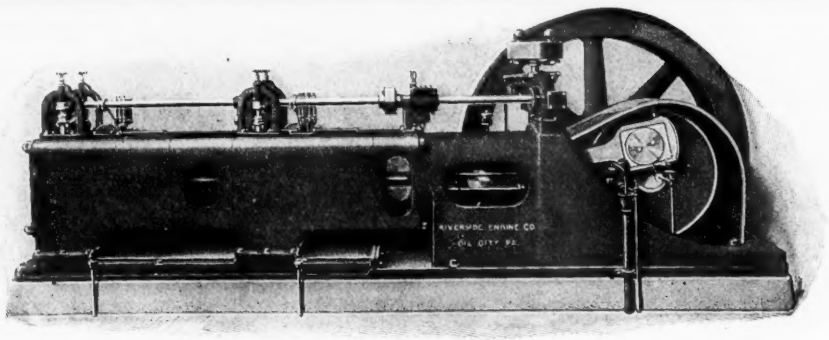

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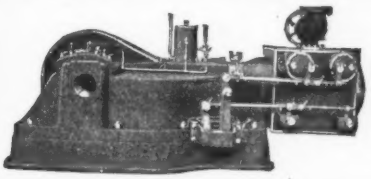

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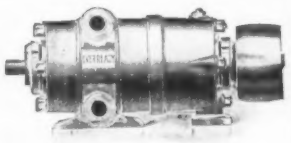

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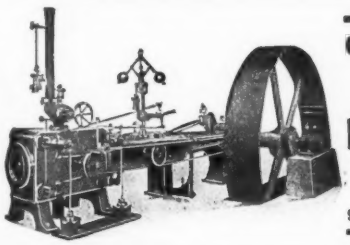

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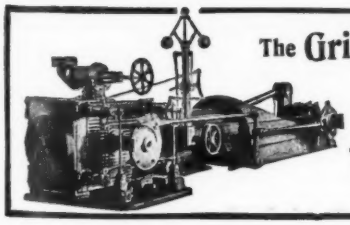

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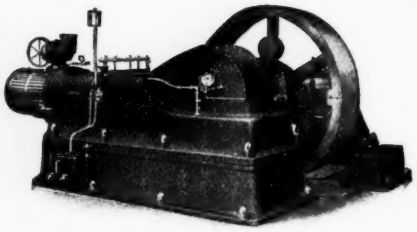

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CENTER CRANK
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SINGLE and FOUR VALVE

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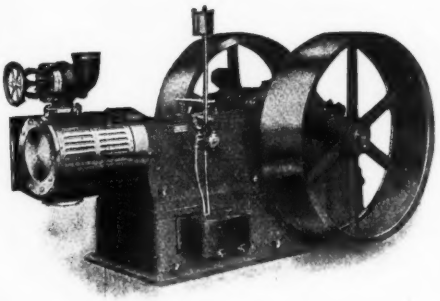

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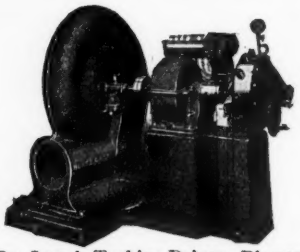

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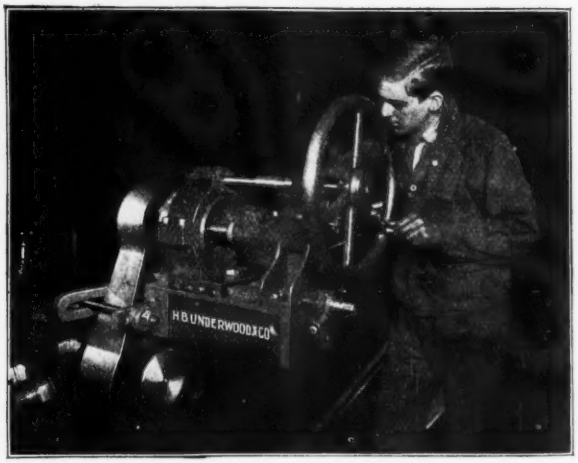


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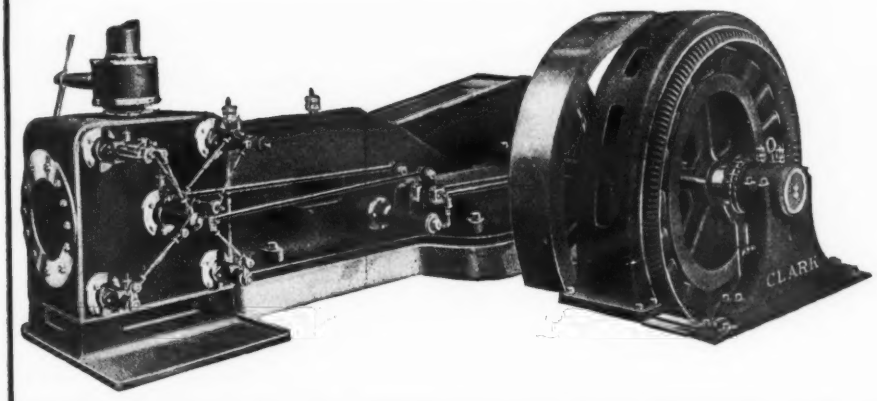
Manufacturers

POWER PLANTS BOILERS






## An Engine Without a Peer

Built simple, tandem and cross compound, and for speeds up to 200 R.P.M. Has ALL the advantages of the releasing gear Corliss, with none of its objectionable features or limitations.

The only Corliss engine ever designed having an unvarying valve travel, with perfect cut off at any point from zero to three quarters stroke. Engineers should investigate this engine. Catalogue free.

**CLARK BROS. COMPANY**
**Belmont, N. Y.**



# BUCKEYE ENGINE COMPANY,

SALEM, OHIO

BUILDERS OF HIGH CLASS

# STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION

AND

ABSOLUTELY RELIABLE

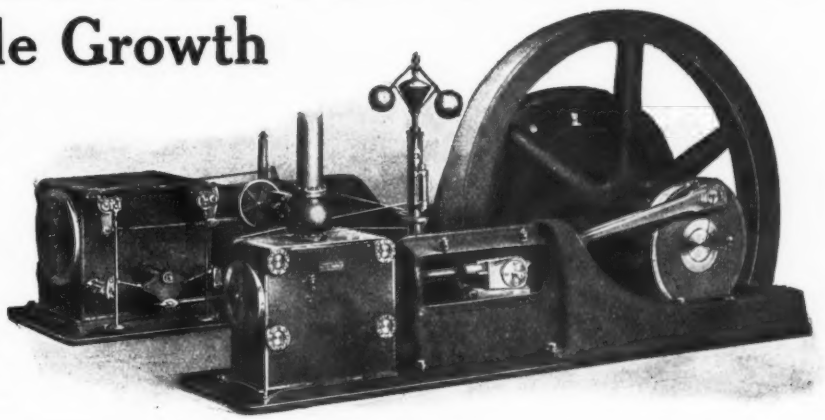
CORRESPOND WITH US BEFORE PURCHASING

CATALOGS ON APPLICATION



# The Remarkable Growth

in the demand for Cooper Corliss Engines has, within the last few years, compelled us to more than double our manufacturing facilities. Ask for particulars.



**THE C. & G. COOPER CO.**
**Mt. Vernon, Ohio.**

BRANCH OFFICES:

New York, 918 Bowling Green Bldg.; Boston, 411 Weld Bldg.; Pittsburg, 604 Frick Bldg.; Philadelphia, Drexel Bldg.; Atlanta, 310 Candler Bldg.; Charlotte, N. C., Court House Square; Chicago, 1539 First Nat'l Bank Building.

# How About Adjustments?

How many adjustments does the average steam engineer have to watch and regulate?

How many lubricators, drip cups and bearing gauges require his daily or hourly attention?

How much time is spent in keeping bearings adjusted for wear? How often is it necessary to shut down to "doctor" a bearing adjustment?

How long would the average generating set run without attention to some adjustment?

How many engineers realize the entire freedom from troublesome adjustments with the horizontal Curtis Steam Turbine Generating Set?

# Do You?

**Figure it out from these facts:**

In the turbine there are either two or four self-aligning main bearings supplied with oil by means of chains, or in some cases, a small self-contained pump, and outside of the main bearings there are a few small bearings in connection with the governing mechanism, and in some cases with the oil pump.

All governor adjustments are correct when the machine leaves the factory and need no attention after machine is first started.

There are many points of simplicity and reliability about these sets that every engineer should know.

Correspondence is invited.

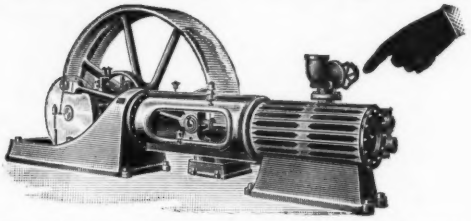
*General Electric Company*

**Principal Office, SCHENECTADY, N. Y.**

**New York Office, 30 Church St.**

**Sales Offices in all large cities.** 1288

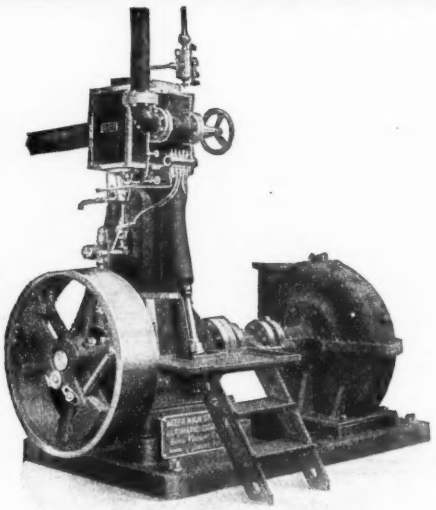
# Fitchburg Engines



Guaranteed steam tight for 25 years on one hour's work per year. Write today for Catalog 61.

**FITCHBURG STEAM ENGINE CO., - FITCHBURG, MASS.**

E. H. Ludeman & Co., 165 Broadway, New York. H. J. Gebhardt, 1419 Fisher Bldg., Chicago. Geo. H. Connor, 509 Mutual Life Bldg., Philadelphia, Pa. W. C. Teas, Chattanooga, Tenn. Western Trading Co., San Francisco.



Bates Vertical Automatic High Speed Engine for connection to Pumps. Especially adapted for

**WATER WORKS, IRRIGATION**

and other places where it is desired to move a large volume of water at small expense.

*CATALOG FOR THE ASKING.*

**BATES MACHINE CO., Joliet, Ill.**

# "The Reeves" "C"

## BEARING METAL

Try this new Babbit. Engineers all say it's the best they ever used—a remarkable improvement on the old brands. 25 cents a pound at dealers—or a 50-lb. trial box *from us.*

Write for details.

**REEVES PULLEY CO., Columbus, Indiana.**

## ENGINE AND BOILER BARGAINS

ENGINES

| | |
|---|---|
| 20 x 42 Allis, Corliss | 16 x 32 Buckeye, Automatic |
| 18 x 42 Hamilton Corliss | 14 x 24 Atlas, Automatic |
| 18 x 36 Wright, Corliss | 13½ x 15 Taylor, Automatic |
| 14 x 24 Wright, Corliss | 12 x 18 Brownell, Automatic |
| 12 x 24 Wetherill, Corliss | 12 x 14 Green, Automatic |
| 10 x 30 Hamilton, Corliss | 12 x 12 N. Y. Safety, Automatic |

Also large assortment of Automatic and Throttling Engines of other sizes.

BOILERS

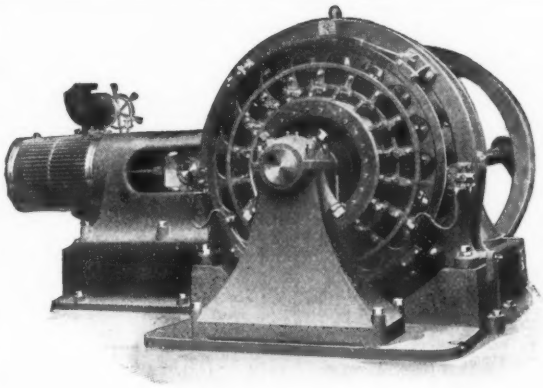
84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.
Write for bargain list.

We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

**THE RANDLE MACHINERY CO.**
**1768 Powers St., CINCINNATI, OHIO.**





# TEAM-WORK

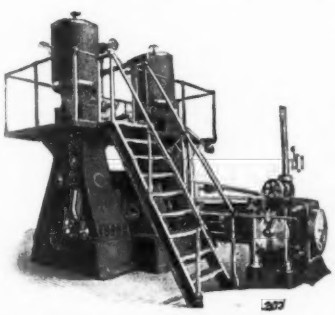
is seen in a McEwen Engine driving a Thompson-Ryan Dynamo. Each is designed to give the highest efficiency when working with the other. And repairs are few and far between.

*WRITE FOR FULL PARTICULARS.*

**RIDGWAY DYNAMO & ENGINE CO.**
RIDGWAY, PA.



## York Manufacturing Co.
**York, Pennsylvania**

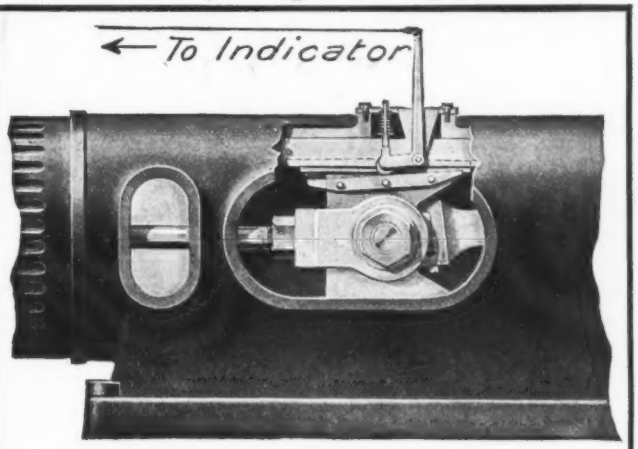


We manufacture all machinery and parts needed to equip a complete Ice or Refrigerating plant—

**Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.**

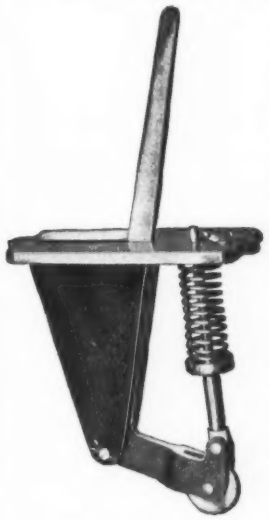
of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.






## EASY TO INDICATE
# AMERICAN-BALL ENGINES.

As an example of the thorough-going way in which AMERICAN-BALL ENGINES are built notice the new indicator reducing motion, built into the frame. You just hook on the cord, start the motion by pressing a detent with your finger, take the card, and stop the motion by shifting the detent again. Leave the cord hooked in place and repeat for each time.



This device gives a theoretically correct motion, is self contained and is always ready and in place. You don't have to hook any swing lever to the roof or erect a temporary structure to support a pantograph, lazy tongs or other mechanism.

This is only one of the superior features of our engines. The AMERICAN-BALL ANGLE COMPOUNDS for instance, have the distinctive advantage that they take up half the space of a single engine of the same power, weigh little for their power, save foundation costs both on account of smaller floor space and because of the absence of vibration, save the labor which others require for frequent oiling and adjustment, and speed regulation, and cannot be equaled by other types of engines of the same capacity.

AMERICAN BALL ENGINES represent 30 years of progressive development.

*Write for Bulletin No. 14.*

**AMERICAN ENGINE CO.**
22 RARITAN AVE., BOUND BROOK, N. J.
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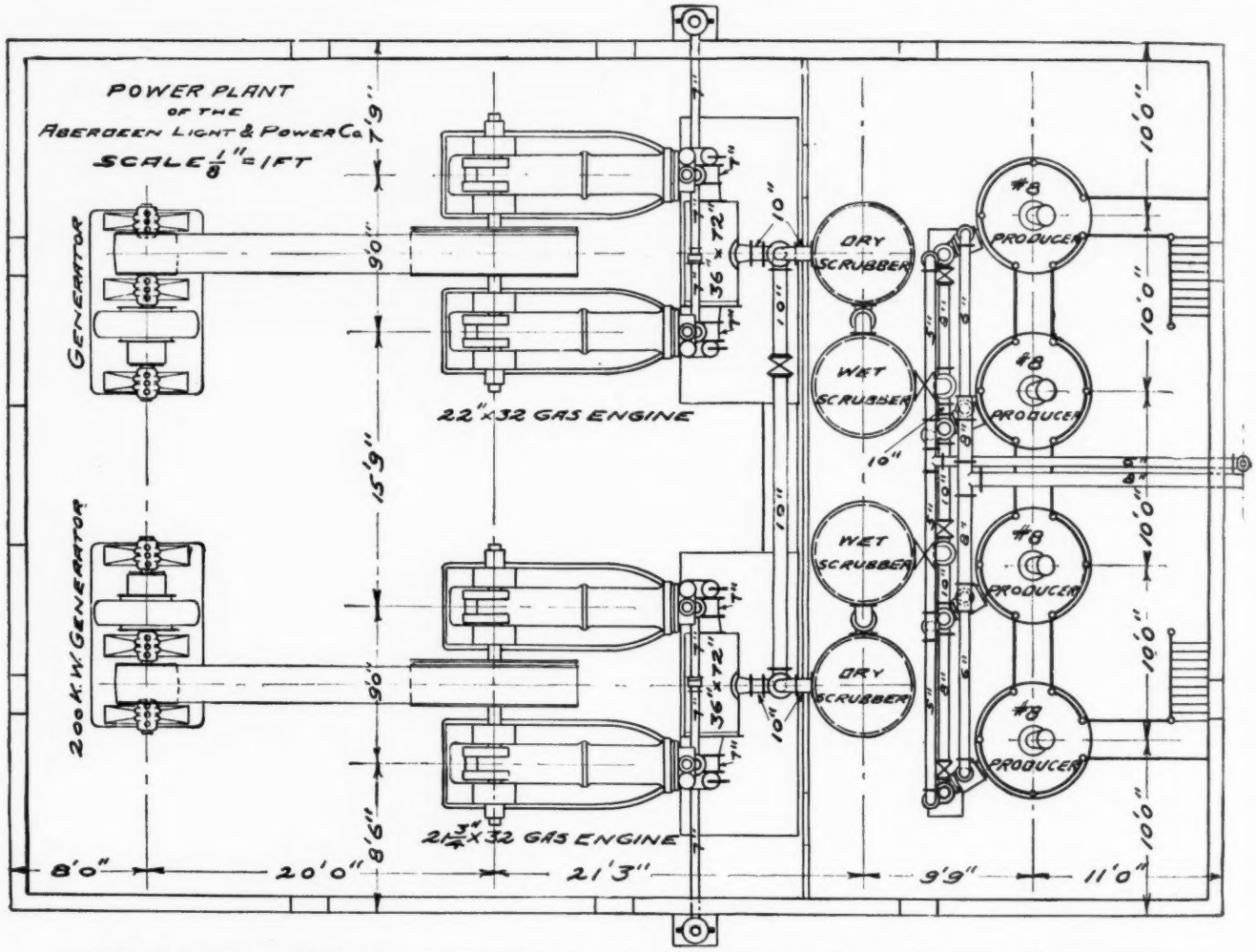
# MINNEAPOLIS STEEL AND MACHINERY CO MINNEAPOLIS




**600 H.P. Muenzel Producer Gas Engines Driving Alternating Current Generators**

The above is a plan of a municipal Electrical Power Plant showing Gas producers, wet and dry Gas Purifiers, Gas Engines and Electric Generators.

Suction Producers, operating on anthracite pea coal are employed. A considerable saving in floor space, the absence of a stack pouring out volumes of black smoke, and

**A SAVING OF APPROXIMATELY 60% IN FUEL COST**

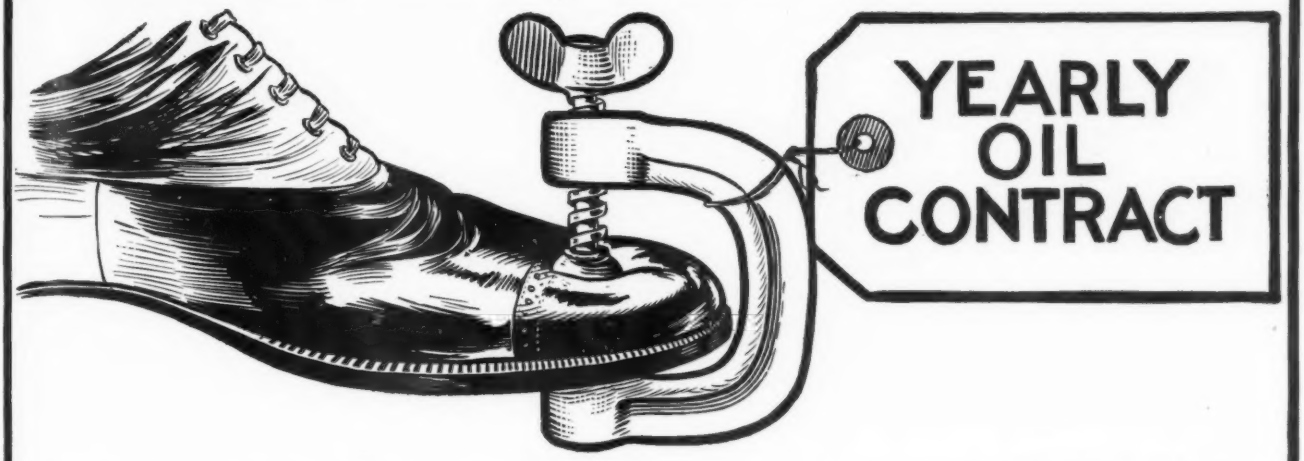
are some of the many advantages of a **Muenzel** Producer Gas Power Plant over a steam plant.

We have been building Producer Gas Power Plants for the past four years and during this time have installed about eighty. Two of these have been destroyed by fire, the rest are in daily operation.

Not one of these plants has exceeded our guaranteed maximum coal consumption of 1 to 1¼ pounds of coal fed to the producer per Horse Power Hour delivered by the Engine at normal load.

We build these plants in sizes from 30 to 1500 H.P.

*WRITE US FOR OUR CATALOG*




# Don't Put Your Foot In It!

By signing a yearly oil contract that makes you pay out a whole lot of money you could easily save by letting your engineers

## Use Keystone Grease

the purest known lubricant, which has a natural body, which will not melt at 300° F., and which is so effective that

## It Practically Annihilates Friction

Keystone Grease is far cleaner than oil, it does not spatter and collect dust and it cannot run out of the bearings and waste away. One pound of "Keystone" lasts longer than 4 to 6 gallons of the best lubricating oil and its superior service multiplies the saving again and again. Lubricating troubles and Keystone Grease are never found together.

KEYSTONE
TRADE MARK
REGISTERED U.S. PAT. OFF.

**See our advertisement on page three.**

## Keystone Lubricating Co.,

**Department B.**

**PHILADELPHIA, PA.**

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Chicago Office—1210 Tacoma Building.
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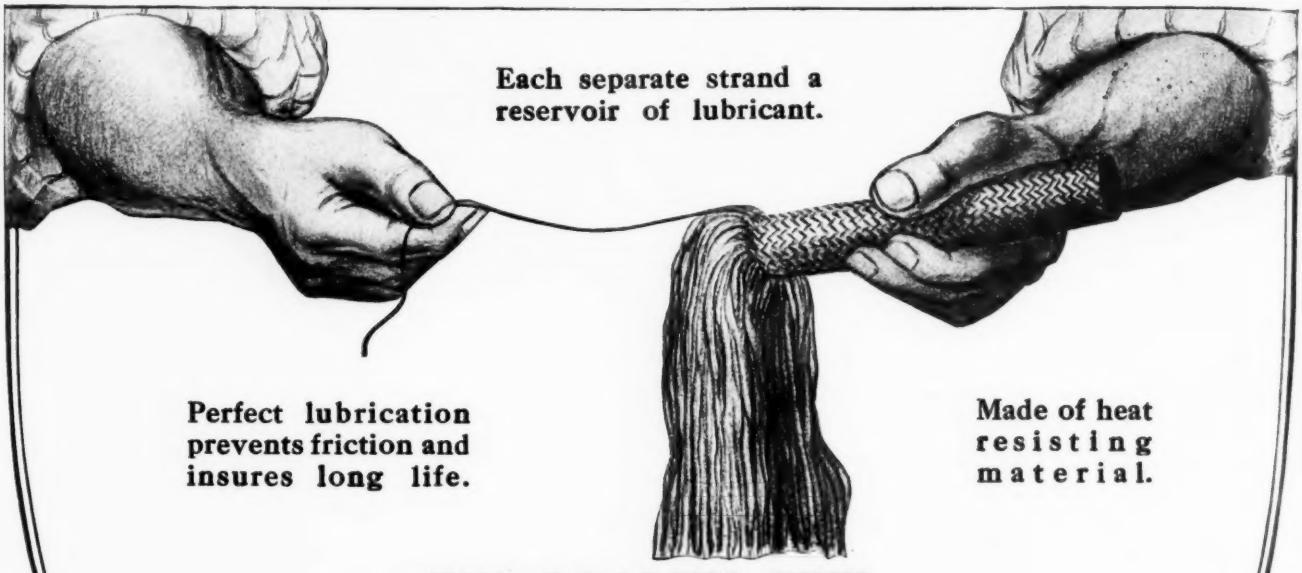

Each separate strand a reservoir of lubricant.

Perfect lubrication prevents friction and insures long life.

Made of heat resisting material.

THE REASONS WHY

# PALMETTO

is the ideal packing for high pressure and super-heated steam, as well as the less exacting conditions.
Send for FREE working samples.

**GREENE, TWEED & CO.**

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**109 Duane St., New York**

# THE BRISTOL COMPANY

MANUFACTURERS OF

## RECORDING INSTRUMENTS

For Pressure, Electricity and Temperature

**Bristol's Recording Thermometers**

**Especially Valuable for Feed Water of Steam Boilers.**

**SEND FOR NEW CATALOGUES.**

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# STARRETT

# SPEED INDICATORS

## OR REVOLUTION COUNTERS

**No. 104.**—This indicator may be run at the highest speed required without heating. The working parts are encased. Dial has two rows of figures, reading right or left as the shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The (O) mark may be instantly set at starting point.

**Price, Postpaid, $1.00**

**No. 107.**—Has all the good points of the above, and in addition has a hard rubber handle for insulation when used on electrical machinery. It also automatically registers the number of revolutions up to 5,000, thus relieving the mind from keeping count.

**Price, Postpaid, $3.00**

*Send for FREE Catalogue, No. 17-R, of Fine Tools.*

**The L. S. Starrett Co.**

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